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APPENDICITIS

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A

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ON

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A

TREATISE

ON

APPENDICITIS

BY

JOHN B. DEAVER, M.D.

SURGEON TO THE GERMAN HOSPITAL, PHILADELPHIA

CONTAINING

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TO THE MEMORY OF MY FATHER

J. M. DEAVER, M. D.

WHOSE CHARACTER AND STERLING QUALITIES AS A PHYSICIAN
HAVE BEEN THE GUIDING INFLUENCES OF MY
PROFESSIONAL LIFE

This Book is Affectionately Dedicated

PREFACE.

The following work on appendicitis has been prompted by the belief that the importance of this affection entitles it to a more thorough and exhaustive study than has usually heretofore been accorded it. Appendicitis in a general way has been so widely and thoroughly discussed that in its usual forms its diagnosis is comparatively devoid of difficulty. No inflammatory affection of the abdominal cavity, however, is capable of such varied symptoms and of so many serious complications, all of which demand the most thorough knowledge for their proper treatment.

It has been my desire to present in this volume such a systematic study of the disease that not only the usual symptoms may be traced from their inception to their termination, but also that the various anomalous conditions so frequently met with may be recognized with equal facility.

I have, therefore, endeavored to emphasize the ætiology, symptomatology, and special technique in the operative treatment. The observations herein contained are the result of an experience in the treatment of over five hundred cases.

I wish to express my thanks to my assistants, Dr. L. Brinkmann, Dr. George Ross, Dr. A. D. Whiting, my brother, Dr. H. C. Deaver, and to Dr. Wilmer R. Batt, for valuable aid in the preparation of the book, and to Dr. W. S. Dougherty, my surgical interne at the German Hospital, for preparing many case reports and for correcting all the proof-sheets.

A number of the pathological drawings were made by Dr. C. Frese, and to him and the excellent artistic work of Mr. F. von Iterson is due the accuracy of that series. I wish also to express my grateful acknowledgment of numberless services performed by Dr. Frese as Medical Superintendent of the German Hospital, where I have done the larger part of the surgical work here represented.

John B. Deaver, M. D.

1634 Walnut Street.

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APPENDICITIS.

HISTORY.

A review of the history of the inflammatory affection in the right iliac fossa, now recognized as a disease of the vermiform appendix, discloses many facts that account for the great diversity of opinions of earlier observers. During the first half of the present century, although cases had been reported in which perforation of the appendix had been found, almost all inflammatory conditions localized in the right iliac fossa were ascribed to diseases of the cæcum. It is probable that lack of knowledge of the distribution of the peritoneum served in part to account for this condition of affairs, as the older writers held that this serous membrane was found only as a covering for the solid viscera contained in the abdominal cavity. In the year 1803 Laënnec first gave a complete description of the peritoneum. His investigations stimulated further observations of this membrane, but as yet there was no association of the fact of inflammation of the general peritoneum with disease in the right iliac fossa,—that is, the latter condition was not considered as causal of the former inflammation. The symptoms of the affection found in the right iliac fossa were described with minuteness and accuracy, but the conditions were not held responsible for the general peritonitis. Even in post-mortem records of cases of peritonitis, no mention is made of the affection of the appendix as a direct cause of the fatal peritonitis.

The first authentic record of the distinct localization of a lesion in the vermiform appendix was that of Mestivier, who in 1759 recorded a case of perforation of this organ. Nothing of importance was gained by the knowledge of this case, except that such a lesion could exist.

In 1827 Husson and Dance described the diseases of the cæcum more in detail, and in 1824, Louyer Villermey reported a case of fatal peritonitis, giving perforation of the appendix as the direct cause. This was the first recorded case in which the true seat of the origin of the disease was recognized. Melier, in 1827, reported four cases, three of which he described as cases of perforative appendicitis with fulminating peritonitis; the fourth was a case of relapsing appendicitis. Both Louyer Villermey and Melier, however, believed that diseases of the appendix and of the cæcum were separate and distinct. Melier described the appendiceal disease very fully, and made special mention of two distinct symptoms in the perforative cases, viz., more or less severe abdominal colic, and fixed pain in the right iliac fossa. He considered the causes, the character, and the consequences of appendicitis, and even anticipated the possible advantage of operation. He says:—

"If it were possible to establish with certainty the diagnosis of this affection, we could see the possibility of curing the patient by an operation. We shall, perhaps, some day arrive at this result."

In 1831, Ferrall published a monograph on "Phlegmonous Tumors in the Right Iliac Fossa," in which he held that in these conditions the cæcum is the organ primarily involved, and that the appendix and the peritoneum do not enter as factors in the production of the phlegmon to as great an extent as does the retro-cæcal connective tissue. He recognized three varieties of tumors, (*a*) a fæcal impaction or distention of the cæcum without inflammation; (*b*) a malignant tumor of the cæcum; (*c*) a true inflammatory or phlegmonous tumor, the

result of irritation of the mucous membrane of the cæcum, or the result of ulceration and perforation of its wall. He also mentions a thickened condition of the peritoneum covering the cæcum as having been found in the phlegmonous tumor.

In 1833, Dupuytren recorded observations showing the connection between abscess of the right iliac fossa and disease of the cæcum, and it is largely due to this great authority that the cæcum as the primary seat of the cause of peri-typhlitis was so widely accepted. In Dupuytren's post-mortem reports, no mention is made of the appendix as the original seat of the disease, and nowhere in his writings does he associate the appendix with the cause of the inflammation of the cæcum.

In 1834, Copland, in his "Dictionary of Practical Medicine," made an advance in the pathology of the troubles in the right iliac fossa. He entered upon the study of the diseases of the cæcum in great detail, and claimed that inflammation of the appendix can be the primary cause of serious affection in the region of the cæcum. He also speaks of the mortification of the appendix, followed by a fatal peritonitis, as the result of a foreign body found within that organ.

In 1837, Burne strove to separate clinically the appendix from the cæcum, although he agreed with the writers of that time, that in the troubles of the right iliac fossa the cæcum is primarily the seat of the disease. He mentions ulceration of the appendix due to a process set up by foreign bodies, such as cherry-stones, raisin-seeds, and fæcal concretions, and adds:—

"So long as ulceration is limited to the mucous membrane, it is of little consequence, but immediately the peritoneum is perforated inflammation ensues; then there is general peritonitis, or local peritonitis with abscess."

In 1839 he wrote a second paper, in which he endeavors to show that the cæcum is of little importance in affections of the right iliac fossa.

In 1838, Albers noted the possibility of disease of the right iliac fossa occurring as the result of inflammation of the vermiform appendix, but he thought that it is more frequently caused by disease of the cæcum. Under the name typhlitis, he described the following varieties of inflammation localized about the cæcum :—

1. *Stercoral typhlitis*—stagnation of fæcal matter in the cæcum, with subsequent irritation.

2. *Simple typhlitis*—catarrhal inflammation due to a multitude of causes.

3. *Peri-typhlitis*—extension of the inflammation of the mucous membrane to the external coat of the cæcum and to the surrounding parts.

4. *Chronic typhlitis*—in which there is a prolonged and slow course. When pus is present and associated with a perforated appendix, he believed that the perforation occurs as a consequence of the pus formation.

In writing of the cæcum, in 1839, Grisolle made mention of fatal cases of appendiceal gangrene. In 1840, Villermey reported cases of inflammation of the appendix that terminated rapidly in gangrene and death. In 1843, Voltz published a paper on "Ulceration and Perforation of the Appendix, Occasioned by Foreign Bodies." His general conclusions were that the appendix was responsible for more of the affections of the right iliac fossa than was the cæcum. Rokitansky was the first to describe catarrhal inflammation of the appendix as due to fæcal concretions or foreign bodies, and believed that this might result either in ulceration or in a chronic morbid condition. He also suggested that a general peritonitis, as a consequence of perforation of the appendix, is not always necessary, because of adhesions to the surrounding structures prior to the perforation. He thought these adhesions were due to a previous irritation.

Although the view that the grave and fatal forms of typhlitis are due to perforation of the appendix gained ground, yet all of the benign and curable forms were considered as the result of inflammation of the cæcum and of the surrounding cellular tissue. This theory has still a few advocates, but, fortunately, they grow less numerous each year.

This much-vexed question has been restored to the status to which Melier advanced it by the surgeons and physicians of the United States, who, by early operation, have demonstrated that inflammation of the right iliac fossa is invariably due, primarily, to disease of the vermiform appendix. Hancock, in 1848, operated on one case. He advocated early operation in disease of the appendix, but his ideas met with no encouragement. In 1867, Willard Parker, of New York, first proved that early operation would save 75 per cent. of all cases. In 1883, Dr. F. F. Noyes reported 100 cases operated upon, 90 per cent. of the operations having been performed in America.

"The epoch-making memoir on this subject" (I quote from Talamon) "is the paper of Reginald Fitz, of Boston, published in the *American Journal of the Medical Sciences* for October, 1886, 'On Perforative Inflammation of the Vermiform Appendix.' In this work Fitz collected reports of 209 cases of typhlitis and peri-typhlitis, and 257 cases of perforative appendicitis. He showed that the symptoms are the same in the latter as in the former class of cases. He studied with care the consequence of perforation. He established the fact that the peritonitis is not always generalized, that it may be circumscribed under the form of an encysted purulent collection. He gave the characters of the tumors formed by this localized peritonitis, the different modes of the evacuation of the pus, the complications that may supervene if the disease be left to itself. He insisted on the frequency of fæcal concretions as a cause of the perforation of the appendix. He concludes in

favor of early operation." In 1888, Fitz published a second paper in which he advanced the radical but sound theory that the diseases described as typhlitis, peri-typhlitis, para-typhlitis, appendicular peritonitis, and peri-typhlitic abscess are all varieties of one and the same affection, namely, appendicitis. Since 1888 the subject of appendicitis has occupied a large proportion of the time and labor of the medical profession, and many able papers have been published advancing widely different views and ideas in regard to it. The most debated points have been concerning the diagnosis and the treatment, and about these the discussion has waged, generally with physicians and surgeons as the opposing disputants.

The frequency of the affection; the rapidity with which the disease may proceed from bad to worse; the fatality in a large percentage of cases; its marked tendency to occur or recur in those who apparently recover from an attack,—these things make appendicitis the most important intra-abdominal lesion of to-day. The work of McBurney, Richardson, Murphy, Morris, and others has greatly advanced the state of our knowledge of the affection, and has done much to present the subject in such a light that the surgeon has been enabled to cope with the disease in a more satisfactory and life-saving manner. Physicians generally, however, take the stand that only a minority of cases require the services of the surgeon, and they claim that only those cases that advance to suppuration, gangrene, and perforation should be seen by the surgeon. Thus the controversy still continues, although prominent physicians of the present day grant that it is advisable to have a surgeon in consultation, even if they do not always give the surgeon the privilege of treating the disease as, in my opinion, it invariably should be treated,—namely, by early operation.

ANATOMY.

The appendix vermiformis of man is the undeveloped true cæcum of some of the lower animals. In the embryologic development of the human intestinal tract, there is at first no cæcum present, the original tract consisting of a straight tube, which has been divided into the foregut, midgut, and hindgut, each division giving rise to different structures. From the midgut springs a diverticulum marking the division between the large and the small intestine. This conical projection lengthens to form the cæcum, "but the terminal portion does not keep pace with the growth of the base, and consequently becomes much narrower in calibre. The basal portion eventually grows so large that it is commonly called the cæcum, while the true cæcum is designated as the vermiform appendix." During the early stages of intra-uterine life, the cæcum with the vermiform appendix lies near the umbilicus, its descent into the right iliac fossa occurring about the sixth month.

In the adult, the cæcum occurs as one of four types, and in each the appendix holds a different position. (Plate I.)

1. In the fœtal type, the appendix is the narrow inferior end of a conical cæcum, the apex of the cone being directly continued into the appendix.

2. A second type consists of a cæcum, with two equally large sacculi at its inferior termination; between the sacculi, which are separated by the anterior longitudinal band, the appendix arises.

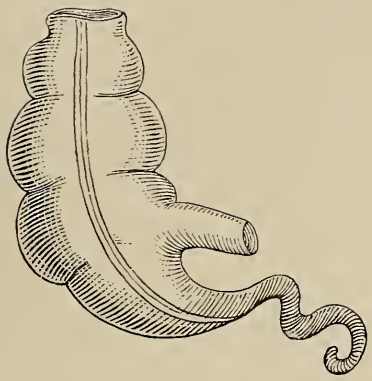
3. In the third class, the external sacculus is large, while the internal one is small, thus bringing the base of the appen-

dix nearer the ileo-cæcal valve. In addition, the anterior wall of the cæcum grows more rapidly than the posterior, so that the root of the appendix is posterior.

4. In the fourth and last class, the internal sacculus has disappeared entirely, and the base of the appendix is attached posterior to the receding angle, between the ileum and the cæcum.

In cases of non-descent of the cæcum, the appendix will hold a correspondingly abnormal position, and, under such circumstances, may even lie to the left of the median line. Lennander mentions the case of a boy of sixteen in whom the cæcum and appendix were found in the left hypochondriac region, lying against the spleen. In this case the appendix measured nine inches in length. Although the average length of the appendix is about four inches, it may vary from half an inch to nine inches. When the appendix is long, the cæcum is, as a rule, somewhat shortened. The diameter of the appendix is that of a goose quill, or about the same as that of a large earthworm. (Holden.)

Before entering upon a consideration of the structure of the appendix, it would be well to trace its peritoneal covering, together with that of the cæcum. The cæcum is almost always entirely covered with peritoneum, although cases have been recorded in which the peritoneum, instead of entirely investing the cæcum, was reflected from its posterior surface, thus forming a meso-cæcum. Generally, the peritoneum is not, as a mesentery, reflected to the abdominal walls from the beginning of the large bowel until the commencement of the ascending colon is reached. It will thus be seen that the cæcum is free in the abdominal cavity, and that from various causes it is liable to change of position. Its mobility may depend upon the presence or absence of a meso-cæcum or of an ascending mesocolon, or upon the length of the large bowel between the tip of



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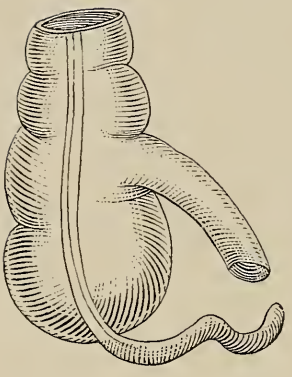

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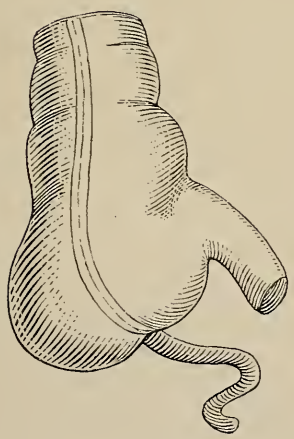

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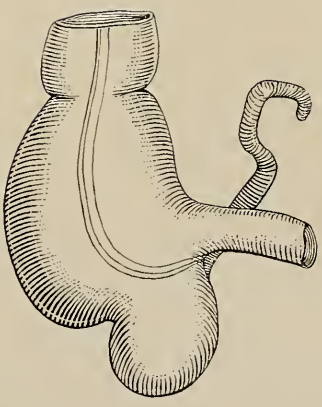


IV

the cæcum and the point of reflection of the ascending meso-colon. The organ may hang over the brim of the pelvis, or it may even occupy the pelvis, and cases have been recorded in which it formed a part of the contents of an inguinal hernia on the right side.

The peritoneal covering of the appendix is reflected from the left or inferior layer of the mesentery of the ileum, and may entirely or in part invest the appendix. The folds of the peritoneum reflected from the ileum to the appendix usually form a mesentery for the appendix, triangular in shape, the base of the triangle being formed by the free edge of the folds. The attachment of the meso-appendix may extend along the entire length of the appendix (as I have usually found it), or it may be attached only to the proximal one-third or two-thirds, thus leaving the tip free. At times the meso-appendix is absent, the appendix, under such circumstances, being free in the abdominal cavity; generally the meso-appendix has the appearance of being too short, and thus the twists and curves often found in the organ may be explained.

The meso-appendix consists of two folds of peritoneum, between which run the appendicular artery and vein, lymphatics, and a few sympathetic nerve-fibers. Occasionally it contains a considerable quantity of fat, which renders it more liable to be torn in the removal of the appendix. The mobility of the appendix depends upon the width and the length of the attachment of the meso-appendix.

At times an opening may be found in the meso-appendix through which a coil of the small intestine has been known to form a hernia and become strangulated.

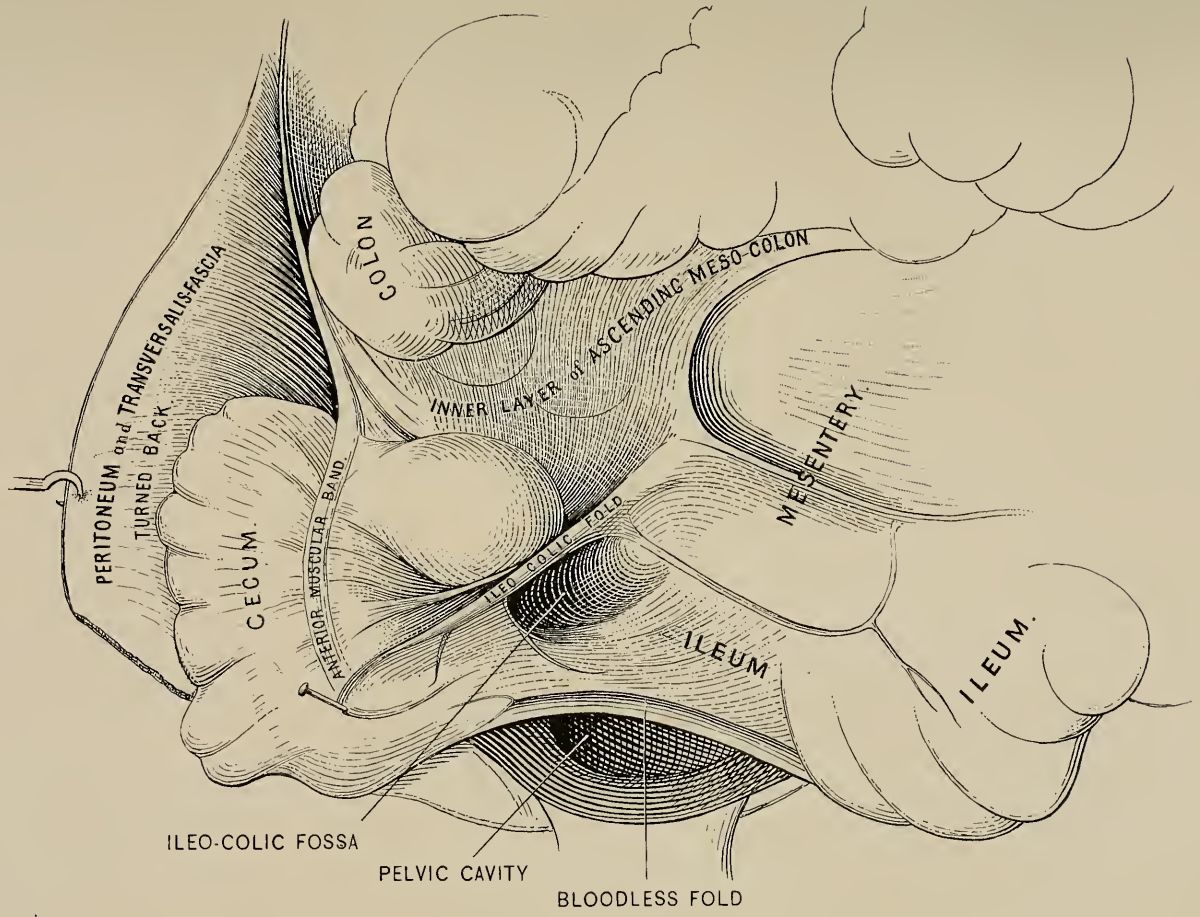
In some cases the iliac vessels have passed through the layers of the meso-appendix. This anatomic condition probably accounts for the manner in which collections of pus in the right iliac fossa may find their way beneath the fascia lata into

the thigh. In the female the meso-appendix has a prolongation running to the ovary, which is described by Clado as the appendiculo-ovarian ligament. It conveys an additional supply of blood to the appendix.

Owing to the various angles and projections formed by the cæcum and the ileum, there are fossæ formed by the reflection of the peritoneum between these parts of the intestinal tract, and they clinically may play an important role. Lockwood and Rolleston first called attention to these fossæ and have so carefully described them that I cannot do better than follow their description: They are three in number, the ileo-colic, the ileo-cæcal, and the sub-cæcal.

The ileo-colic fossa (Plate II) is a peritoneal pouch formed at the angle of junction of the ileum and colon. The floor is formed by the mesentery and sometimes by a portion of the ileum. The ileo-colic fold of peritoneum forms its roof. This pouch is variable in size and depth, and as it is too high up does not play a very important part in appendicitis. A branch of the ileo-colic artery runs through the ileo-colic fold, crossing in front of the ileum.

The ileo-cæcal fossa (Plate III) is a peritoneal pouch, situated behind the angle of junction of the ileum and cæcum. To expose it both the ileum and the cæcum must be elevated. It is bounded on the right by the mesentery of the ascending colon, and on the left by the mesentery proper. The roof is formed by the ileo-cæcal fold, a bloodless fold of peritoneum extending from the free border of the ileum to the cæcum and finally joining the surface of the meso-appendix. This fossa may be very deep and long, at times extending upward behind the ascending colon as far as the kidney and duodenum. The mesentery of the appendix sometimes divides the fossa transversely, thus forming two fossæ, known as the superior and inferior ileo-cæcal fossæ.


PERITONEUM and TRANSVERSALIS-FASCIA TURNED BACK
COLON
INNER LAYER of ASCENDING MESO-COLON
MESENTERY.
CECUM.
ANTERIOR MUSCULAR BAND.
ILEO COLIC FOLD
ILEUM
ILEUM.
ILEO-COLIC FOSSA
PELVIC CAVITY
BLOODLESS FOLD

The ileo-cæcal fossa is important, as the appendix is often found in it, thus explaining why this location is often the site of certain products of appendicular disease.

The sub-cæcal fossa (Plate IV), as its name implies, is immediately under the cæcum, the latter portion of the bowel requiring to be raised in order to view it. It is less constant than the other fossæ. The mouth of this fossa is found at the junction of the cæcum with the colon, the fossa separating the layers of the meso-colon. On account of its high position, it does not clinically play a prominent part. If, however, a meso-cæcum were always present, this fossa would be a very important one, as the mouth of the fossa would then be flush with the tip of the cæcum, at the base of the appendix. Lockwood and Rolleston have described this condition as occurring, but I have never yet seen a case with a meso-cæcum. The appendix may occupy either of these fossæ, but more often it is found in the ileo-cæcal or the sub-cæcal. On account of the various complications that may arise if the appendix occupy either of these fossæ, the operator may be led to form an incorrect conception of the true state of affairs. Thus at times the appendix might constitute a retroperitoneal hernia; or if the appendix should occupy one of these fossæ and the mouth of the fossa should close over the organ, the organ might be thought absent. Suppuration of the appendix so walled in would be entirely circumscribed.

In the majority of cases, the appendix will hold one of eight positions. Dr. Bristow suggests a very simple method of classifying these positions and directions, which consists in locating a central point in the right iliac fossa which, in its most common position, will represent the attachment of the appendix to the cæcum, and from this central point lines are drawn that radiate in eight different directions. To indicate the course of the different lines, Fowler has modified this method

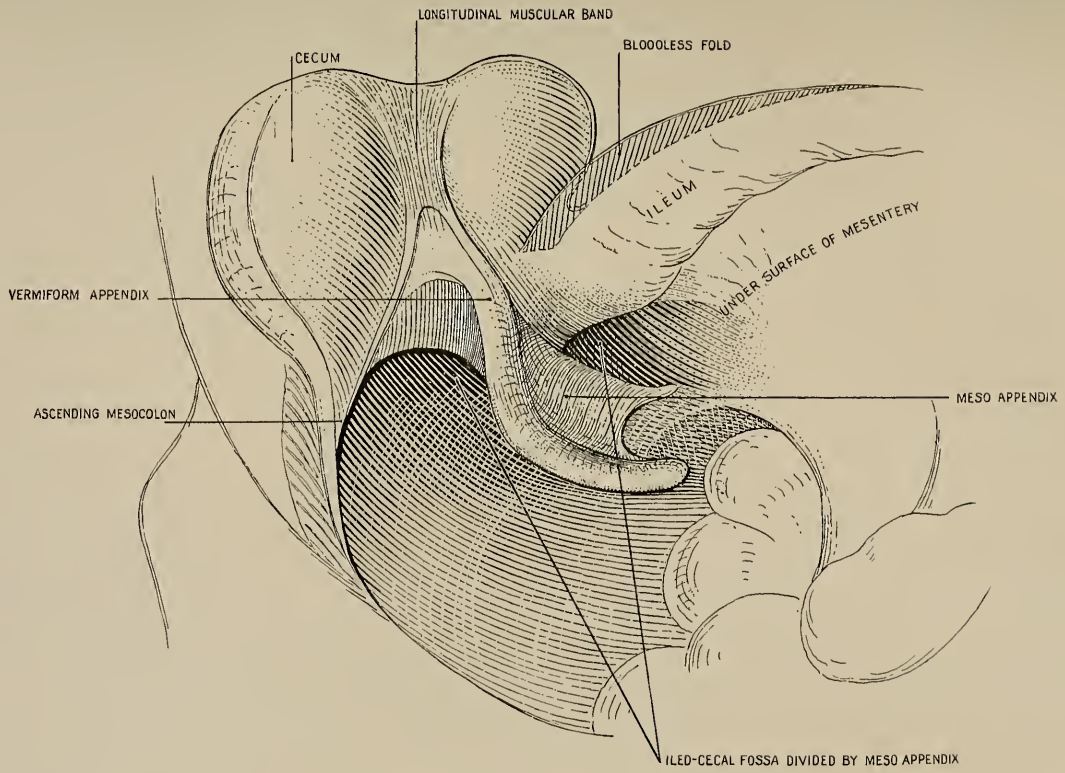
by substituting the initial letters of the points of the compass for the numbers used by Bristow. The central point is located by drawing a line from the anterior superior spine of the ilium to the umbilicus; a point on this line, from two to two-and-a-half inches from the anterior superior spine, corresponding to the central point from which the lines are drawn.

Although, normally, the appendix may occupy any of the eight positions, it is most commonly found in one of the following five: 1. It may lie under the inferior layer of the mesentery, being directed toward the spleen, in the N. E. position. 2. It may lie on the ilio-pectineal line or project into the pelvis, its course being S. or S. E. 3. If there is a long meso-appendix, it may lie to the right of the cæcum and ascending colon, running upward, in a northerly direction, parallel with the colon and over the kidney toward the right lobe of the liver. 4. It may lie in front of the colon and cæcum, its course generally being N. or N. E. 5. It may lie under the cæcum, holding generally a northerly direction. If the appendix has a long and wide mesentery, it may hold any of the other three positions, freedom of motion generally being required in order to assume these positions.

Abnormally, the appendix may hold a position in either of the ileo-cæcal fossæ; it may lie behind the peritoneum and behind the cæcum and adherent to its posterior muscular wall (Plate V), being covered in this position by the peritoneal covering of the cæcum; it may be adherent to the peritoneum along the right border of the cæcum and ascending colon; it may be adherent to the peritoneum at any point in the neighborhood of the cæcum; or it may lie in the inguinal canal.

The structure of the appendix is very similar to that of the large intestine, but varies somewhat from the latter. The mucous membrane lining the appendix is composed of a delicate retiform tissue containing numerous lymphoid cells within

PLATE III


LONGITUDINAL MUSCULAR BAND
CECUM
BLOODLESS FOLD
ILEUM
UNDER SURFACE OF MESENTERY
VERMIFORM APPENDIX
MESO APPENDIX
ASCENDING MESOCOLON
ILEO-CECAL FOSSA DIVIDED BY MESO APPENDIX

its meshes, and has dipping into it a plentiful supply of solitary glands and glands of Lieberkühn. The latter glands vary much in size and number and are often entirely absent. As a rule, the retiform tissue is lined with a basement membrane on which are found columnar epithelial cells covered with clusters of various micro-organisms. Between the mucous and submucous coats, a thin layer of circular muscular fibers may be distinguished, forming the *muscularis mucosæ*. The submucosa is formed of areolar tissue, is much denser than the mucous coat, and contains numerous lymphoid glands. In the submucosa are numerous small arteries and veins supplying the mucous membrane; it generally contains a small quantity of fat.

From within the cæcum there is seen a prominence of the mucous membrane, partially or completely surrounding the orifice of the appendix, due to an increase of the lymphoid tissue. This, under certain circumstances, may act as a valve, and thus favor occlusion of the orifice.

The muscular coat consists of two layers. The inner is a thick layer of circular fibers, at times constituting fully one-third the entire thickness of the appendiceal wall. The outer layer is composed of longitudinal fibers. It is not so thick as the inner, nor are the muscular fibers as regular, as at times they are bunched at certain points in a manner similar to this layer in the cæcum.

Probably one of the strongest points of evidence as to the existence of the longitudinal muscular fibers is demonstrated after the removal of the vermiform appendix, when the organ rapidly shrinks by their contraction, sometimes one-third of its original length. The circular fibers possess the same power, for when the appendix has been incised to expose its canal there will be immediately noted a contraction of the circular fibers, thus bringing the mucous lining into view.

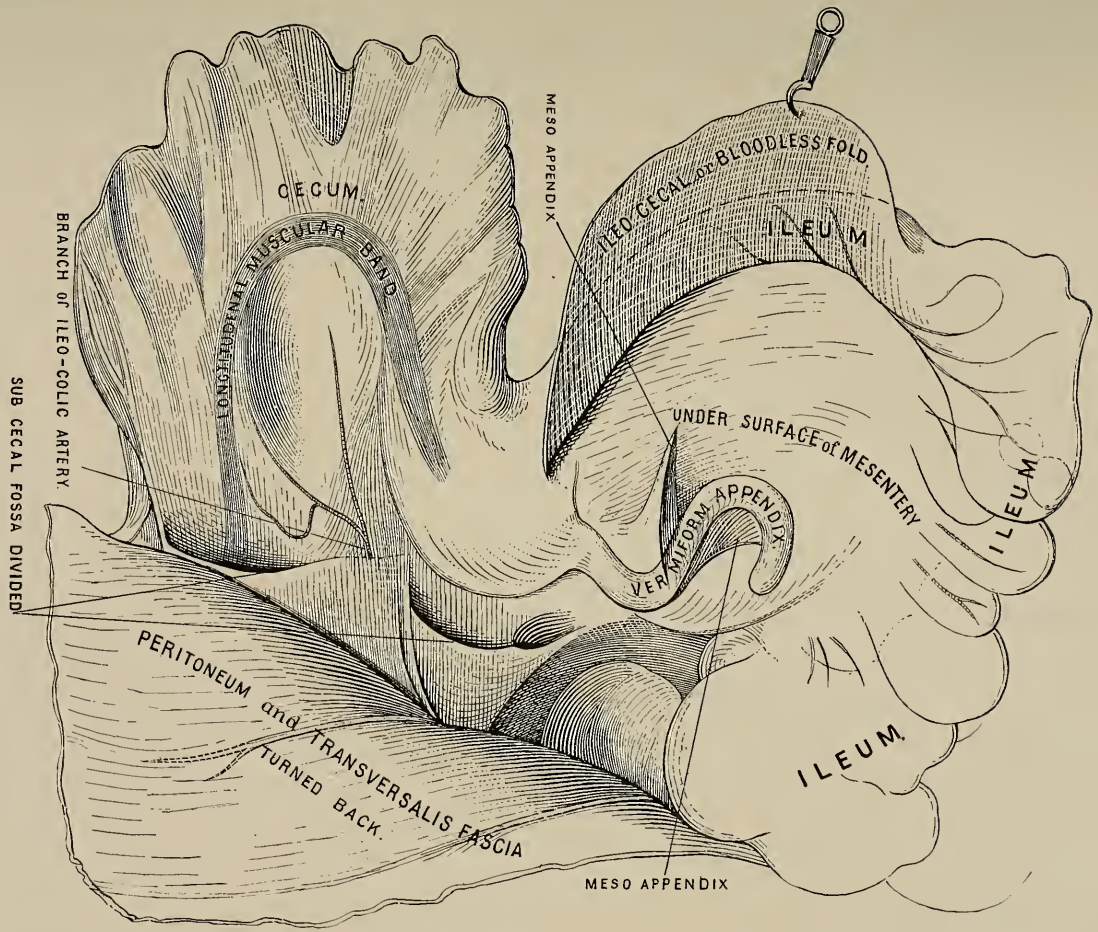
The peritoneal coat, or serous covering, of the appendix is

similar to the peritoneum in general. Its extent in regard to the appendix has already been described.

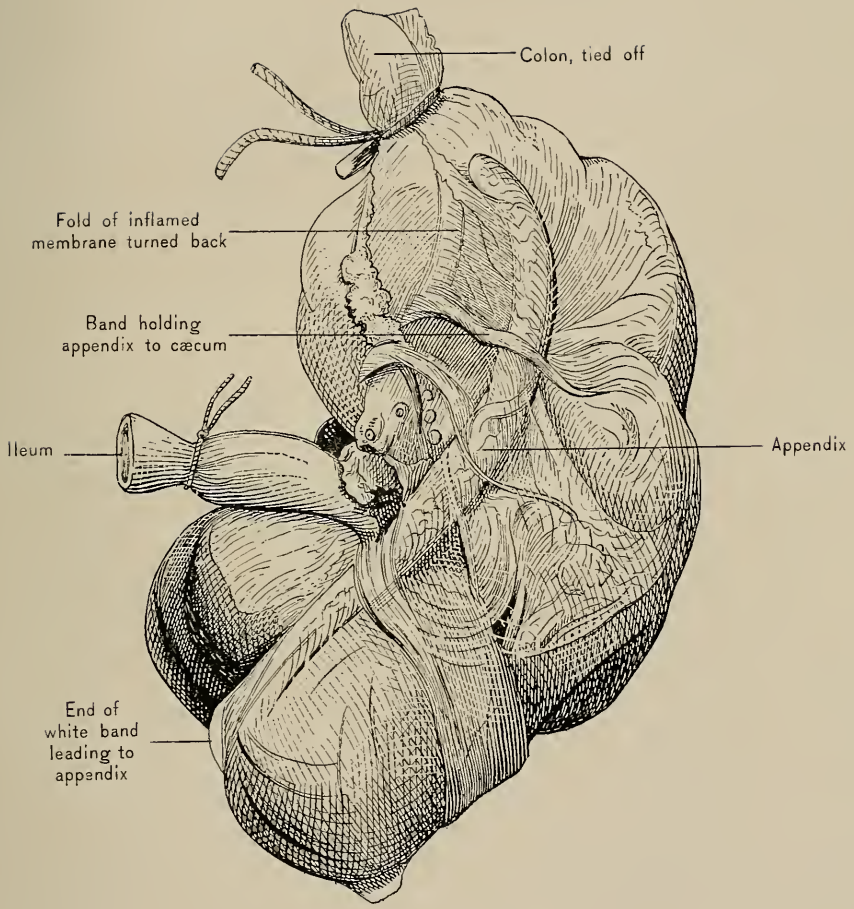
The vascular supply of the right iliac fossa is derived from a loop formed by the anastomosis of branches of the superior mesenteric, the right colic, the ileo-colic, and the middle colic arteries; from this loop secondary loops are given off and from these are derived the arteries to the appendix and to the ileo-cæcal region. The branch to the appendix, the appendicular artery, passes along the free edge of the meso-appendix, if that structure is present. In the absence of the meso-appendix, the artery usually passes beneath the peritoneal coat of the appendix. In exceptional cases the artery may pass directly to the tip of the appendix, in which instances it will not give off branches until it has entered the submucosa.

In the female, at times, there is an additional supply of blood brought to the appendix through the folds of the appendiculo-ovarian ligament. The lymphatics of the appendix pass to a chain of glands in the angle formed by the junction of the appendix with the cæcum. The lymphatics may empty into those of the ovary by passing along the appendiculo-ovarian ligament, in this way forming a communication between the appendix and the ovary.

The nerves of the appendix are derived from the superior mesenteric plexus of the sympathetic, the branches of this plexus, which accompany the ileo-colic artery, sending filaments to the appendix. As this plexus gives numerous twigs to the small intestine, it is easily explained why pain, due to disease of the appendix, may be referred to the whole abdomen or to any region of it.



THE BLOODLESS FOLD in the body from which this drawing was made did not join the MESO-APPENDIX as is usual



Back View of Cæcum, with appendix attached, the latter covered by serous coat of Cæcum. The illustration shows the difficulty encountered in the removal of an adherent appendix

ÆTIOLOGY.

The earlier writers on appendicitis usually held that the main cause of this affection was the presence of a foreign body in the appendix. Since, however, the true character of the disease has become known, the presence or absence of a foreign body, such as a cherry-stone, a grape-seed, etc., has played little part as an ætiologic factor. Two classes of causes of appendicitis, the predisposing and the exciting, are at present recognized.

Predisposing Causes.—Among these the anatomic structure of the appendix must be considered, because its liability to variations, in position and size, is probably one of the principal causes of the affection. The appendix, functionless and undeveloped, is a narrow, musculo-membranous tube, lined with mucous membrane, ending in a blind extremity having a common orifice of entrance and exit; its blood-supply is limited, consisting of one small artery, with no anastomoses to make up for the deficiency of supply; it is an organ of low vitality on account of the retrograde metamorphosis it is undergoing in the process of evolution; it is rich in lymphoid tissue, a fact that vastly increases its absorptive powers, and when attacked by inflammation is, therefore, more liable to progressive destructive processes. If the appendix hold a pendent position, there will necessarily be more resistance offered to its efforts to empty itself of any material lodging in it. If it lie in a position in which gravity can play a part in the discharge of the contents, there will be correspondingly less liability to disease. The attachment of the meso-appendix, together with its length, also act as factors of some moment.

If the mesentery be long, the tube will probably be straight and not subject to twists and kinks. If, on the other hand, the meso-appendix be short, the organ will always be curved on itself and at times twisted, thus favoring the retention of any material that may have become lodged within it. These anatomic conditions predispose the appendix to catarrhal inflammation, producing infiltration of the submucous layer resulting in thickening, which impairs appendicular peristalsis and also interferes with free drainage.

A marked predisposing factor in recurring inflammation of the appendix is the fact that it has already been the seat of disease. In the apparent recovery from the first attack, the mucous membrane of the appendix undergoes a healing process by which the lumen of the organ is constricted either at the orifice or at points along its length. If these constrictions completely close the lumen at any part, they must, of course, prevent the egress of any material that may have lodged beyond them. Even if not entirely closing the lumen, the constrictions are liable to act as hindrances to the drainage of the organ and to the expulsion of any contents, and thus there will be retained in the cavity a nidus for further trouble. While it is true that these constrictions may be thought to possess the power of preventing the ingress of foreign material, yet it must be acknowledged that there is greater liability to the ingress of material than to its egress, owing to the great difference between the propelling force of the bowel and the repelling force of the diseased and weakened appendix.

In a very few cases, it is probable that the cicatricial process extends along the whole length of the appendicular canal, in this way entirely obliterating its lumen, and, consequently, absolutely preventing further attacks of the disease. The number of cases in which this occurs is, however, so small that it may be set aside.

Mucous membranes throughout the body, *e.g.*, of the throat, bladder, intestinal tract, stomach, etc., are liable to a catarrhal inflammation, and there seems no good reason for believing that the mucous membrane of the appendix is an exception to the rule. The same causes that are effective in the production of catarrhal inflammations elsewhere, are probably equally active in the appendix. While in other localities they may provoke no serious results, they cause disastrous lesions in the appendix.

Age is a predisposing cause. Although the disease is most common in those between the ages of ten and thirty, about 15 per cent. of all cases occur in persons under fifteen years. The youngest patient in whom I met with the disease was not two years of age, and the oldest seventy. An explanation for this marked susceptibility, up to adolescence, may be found in the disturbances of the gastro-intestinal tract, so frequently induced by indiscretions in diet.

As to sex, males are much more prone to attacks of appendicitis than females. There is but one reasonable explanation for this, viz., the fact that females are supposed to have a greater blood-supply than the males, both in actual quantity and in proportion to the size of the appendices in the two sexes. Clado has described a fold of peritoneum extending from the appendix to the ovary, the appendiculo-ovarian ligament, which carries a blood-vessel to the appendix. This, together with the fact that the appendix of the female is smaller than that of the male, may account for the comparatively small per cent. of attacks among women and girls.

It is not probable that either constipation or diarrhœa play a very important rôle in the causation of appendicitis, as statistics have shown that the large majority of cases have a normal condition of the bowels prior to and during an attack.

When tuberculosis, secondary to the involvement of the cæcum, is more pronounced in the appendix, it is likely to be followed by a result similar to that of acute perforative appendicitis.

I have had cases due to exposure to cold and wet. In one the attack was provoked by taking a cold shower after coming out of a warm bath, another was the result of wet feet, and a third from being chilled by lying in a cold room shortly after a heavy meal.

I believe typhoid fever to be one of the remote causes in the production of appendicitis. The appendix contains many solitary glands which at times are the seat of typhoid ulcers, and, as a result of the cicatricial contraction of these ulcerated patches, obstruction to the lumen of the appendix occurs.

In certain cases of chronic appendicitis, developed post-typhoid, I have been unable to elicit a history of previous acute intestinal disturbance. Yet in these I have found a train of symptoms—intestinal dyspepsia, vague pains in the abdomen, etc., the origin of which was traced, without doubt, to an attack of typhoid fever that had occurred months or years previous. This is illustrated in the following case:—

Miss I. M. W., first troubled with mucous discharge from bowel in the summer of 1889, when she had an illness called typhoid fever, attended by frequent watery, and in some instances, bloody discharges. Was confined to bed about three weeks. Tedious recovery. Since this illness she has been subject to attacks of catarrhal enteritis, never escaping for more than four months, although well during that time. These attacks, which could be traced to cold, unusual exertion, sea-sickness, etc., were less frequent in the autumn and early winter, after the change of air and rest during the summer. Two years ago in June she had a persistent attack lasting several weeks. Vague pains were present in right iliac fossa and a distinctly enlarged and tender appendix could be made out on palpation.

Operation. No adhesions; the appendix contained pus, and was indurated. The mucosa and submucosa were thickened, and showed marked evidences of chronic catarrhal inflammation.

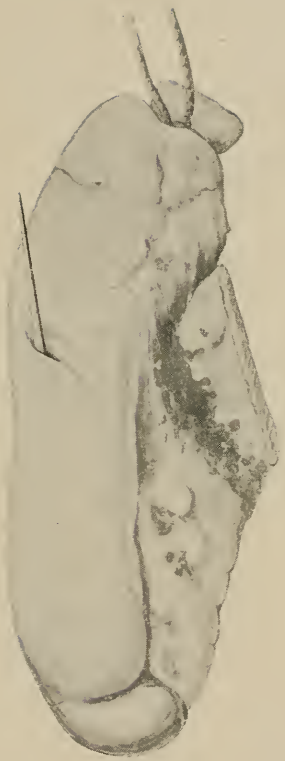
Recovery followed with total disappearance of symptoms.

ACUTE APPENDICITIS.

Mrs. A. G., aged thirty-three, was admitted to the German Hospital, May, 1896, with the following history: Ten days previously she had been suddenly seized by sharp pains in her right side, attended by vomiting. The abdominal wall was rigid and markedly tender on pressure over the region of the appendix. Constipation was present. The vomiting lasted for two days, but the pain, tenderness, and rigidity continued for one week, gradually decreasing meanwhile.

On date of admission her temperature was 101°; pulse rate 112; stomach not irritable. Her abdomen was slightly swollen, and in her right iliac fossa close to the iliac spine was a mass the size of an orange, which was *not* painful on pressure, though moderate tenderness existed upon deep palpation. Appendicitis was diagnosed, but on account of the absence of pain and tenderness in the mass over the appendix, which seemed an anomalous condition, operation was deferred for one day. Her temperature, however, steadily rose to 103°, and immediate surgical interference was considered necessary.

Section of the abdominal wall showed the muscles infiltrated. The parietal peritoneum was closely adherent to a mass which was composed of omentum, and the appendix bound together by organized exudate. No pus was found. The appendix was freed, tied off, and removed, and upon examination proved to contain a black pin, which had entered the canal point first. This case is particularly interesting from the fact that, despite the mass, pain and tenderness were not marked. It also illustrates that in the absence of great local tenderness, a diagnosis of pus in or about the appendix is not warrantable.



Showing Appendix containing Pin

(Twice natural size)

Another of the predisposing causes is the fact that the basement membrane of the mucous lining of the appendix is almost always the seat of clusters of micro-organisms that are ever ready for an opportunity to attack the structure of the organ and thus set up an acute inflammatory condition. The rôle played by micro-organisms will be more fully discussed under the chapter on pathology.

Exciting Causes.—It is probable that all cases of appendicitis are directly due to the invasion of micro-organisms. This may occur independently of any other change in the region of the appendix or of the intestinal canal, or it may be directly due to disturbances brought about by several causes. For instance, changes in the blood-supply of the appendix, the result of a bend or twist, may so lower the little resisting force the organ possesses that the micro-organisms are given full play. Disturbances of digestion are claimed by many authors to be exciting causes. Fowler holds that these play a very unimportant part. Talamon, on the other hand, thinks that peristalsis, induced by the presence in the intestinal tract of irritating material, is liable to engage a stercoral calculus within the orifice of the appendix, and that this gives rise to symptoms found in the first stages of the disease. It is claimed, also, that this erratic peristalsis awakens the micro-organisms to a more virulent condition, thus enabling them to inaugurate more easily inflammatory conditions. I am positive that acute indigestion plays a very important rôle in the ætiology of appendicitis. I have seen this demonstrated so often that I express this opinion unhesitatingly. The introduction of foreign substances into the lumen of the appendix, such as cherry- or date-stones, pins, etc., is an infrequent cause of appendicitis. It is true that seeds, pits, pins, etc., have been found in the appendix. The case of Mrs. A. G. (page 36, Plate VI) illustrates this, but it is probable that in the large majority

of these cases the supposed seeds, etc., were fæcal concretions, as these concretions bear a very striking resemblance to such foreign bodies.

Fæcal concretions, though not the direct cause, are probably the most frequent exciting cause of acute affections of the appendix. It was formerly the accepted opinion that fæcal concretions, having formed in the small intestine, migrated into the appendix and there set up inflammation with its disastrous consequences. This view is no longer held. The course of events seems rather to be as follows: A small normal fæcal particle being carried into an appendix, the mucous membrane of which is inflamed, is there retained, the swollen membrane, the inflamed muscle, and the abnormal adhesions inside the appendix preventing its egress. The concretion is gradually increased in size by concentric layers of mucous and purulent products deposited on it. As it grows the appendix is dilated (Fig. 1). At first no injurious effect may be evident. When, however, the concretion has attained considerable size it becomes directly harmful to the mucous membrane, causing then pressure-necrosis and gradual perforation of all the histologic layers of the appendix. (In the case of Wm. ——, herewith presented [Plate VII], perforation was imminent, the walls of the appendix having become so friable that they parted upon the slightest pressure.)

The fact that the large concretions often found could not possibly have been introduced without tearing the appendiceal opening, is sufficient proof of the growth of the concretions after their lodgment in the appendix.

We conclude, therefore, that while the formation of coproliths stands in close relation with diseases of the vermiform appendix, they are not the primary cause, but rather a consequence of the disease. They develop when an appendicitis already exists, and only afterward assume dangerous tendencies; they

CHRONIC APPENDICITIS.

Wm. ——, age thirty-six. Had always enjoyed good health ; had been a member of the crew when a student at Harvard College.

On November 15, 1895, was seized suddenly, after a long ride in a cold, damp wind, with what seemed at first to be a severe attack of indigestion. Within a few hours pain became intense, with marked tenderness on pressure over the appendix, soon followed by general abdominal distention. Constipation present. Calomel and ounce doses of Rochelle salts were given by mouth, followed by an enema of Epsom salts (two ounces in hot water). After copious evacuations the tenderness subsided, and in a few days he was up and attending to business, though not entirely well.

On December 15th, after a heavy meal, a second attack was excited, which likewise subsided upon free purgation, leaving him in the same condition as before.

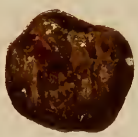
On January 7th a third attack occurred, which subsided but slightly after above treatment. Surgical interference was then decided upon.

The operation (performed January, 1896) was complicated by a very fat and muscular abdominal wall. Appendix pointed N. and lay behind the cæcum, which was tied down ; meso-appendix contained a small purulent collection. Very fat and long omentum and meso-colon ; cæcum perforated ; perforation closed under most unfavorable conditions. The appendix, which contained a large fæcal concretion, giving it the appearance of the fundus of a gall bladder, was removed. It was ulcerated off the cæcum. Iodoform gauze drainage was carried down to and covering the sutures in cæcum, in case the sutures should not hold.

Recovery uninterrupted. In protecting the peritoneum and in the technic of the peritoneal toilet in this operation, ninety pieces of gauze were used. This case is rather exceptional, in that the gangrene occurred on the proximal side of the concretion.

Appendix ulcerated off caecum

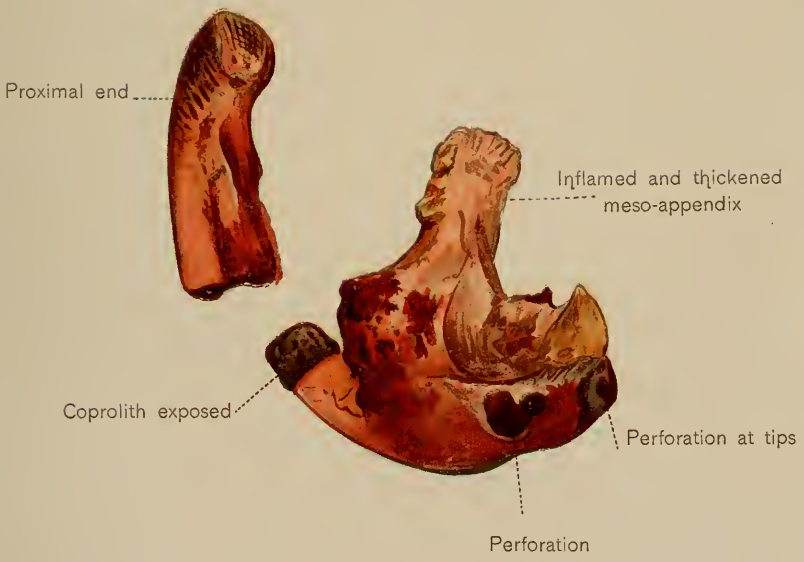
Tissue at lower end exceedingly friable, slight pressure causing it to break with extrusion of coprolith



CHRONIC APPENDICITIS.

F. Zollers, age twenty-one. First attack: was seized, after eating, with acute abdominal pain, vomiting, etc. Cardinal symptoms marked.

Operation was performed on the seventh day of the disease; a large quantity of pus was present. Appendix was perforated in two places, at and near the tip. It contained near the middle a large fæcal concretion. In the plate this concretion has been shown by cutting the appendix at that point. Patient died two weeks after operation. Autopsy showed field of operation clean. Gangrenous patch two inches in length, involving half the circumference of a loop of ileum occupying the pelvis. Gangrenous patch perforated, allowing escape of small quantity of fæcal matter into pelvis. No pus was found in the pelvis. No connection between disease of ileum and field of operation. The involved coil of ileum enveloped in mass of exudate. The exudate evidently the result of the peritoneal inflammation which had extended from the appendix by contiguity.


Proximal end
Inflamed and thickened meso-appendix
Coprolith exposed
Perforation at tips
Perforation

then serve as pathologic factors by mere interference with drainage, thereby preventing the emptying of the appendix. Again, by constricting the lumen, and causing pressure and interference with the circulation, they favor gangrene of the organ on the distal side of the concretion (see case of F. Z., Plate VIII). Moreover, by inducing pressure-necrosis, they allow micro-

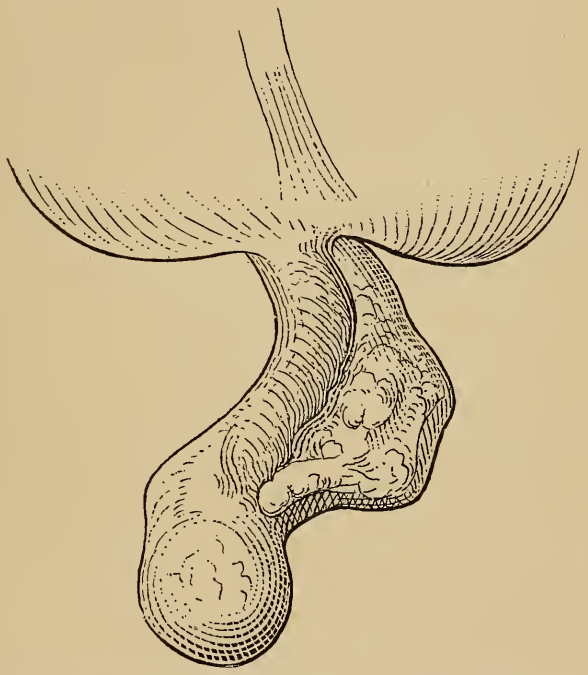


Fig. 1.—Showing Situation of Fæcal Concretion and Dilatation of the Appendix in the Case of Wm. ———, Before Occurrence of Gangrene and Sloughing of Appendix. See Plate VII.

organisms to invade the structure of the organ, and thus set up the true inflammatory disease. This pressure-necrosis also induces greater probability of a perforation. It is a well-established fact, demonstrated by abdominal section performed for other diseases, that fæcal concretions are often found in perfectly normal appendices, and it has also been proved that we may have

acute inflammation of the appendix, and even perforation and gangrene, without the presence of fæcal concretions or inspissated mucus. In these cases it is probable that there has been some interference with the circulation or with the activity of the expelling force of the organ.

To sum up: I believe that there are many factors that predispose to appendicitis, among them being the anatomic structure of the appendix, its position, its inadequate drainage, the length of the appendix and of the meso-appendix, a previous attack of local inflammation, typhoid fever, age, and sex. I believe that all cases of appendicitis are directly due to the invasion of certain micro-organisms; that fæcal concretions act as a pathologic factor by stenosis of the lumen of the appendix, or by interference with the circulation, or by setting up pressure-necrosis; that there are cases in which the fæcal concretions play no part in the cause of the affection; that foreign bodies, such as grape-seeds, cherry-stones, etc., may, at times, be the direct cause of the invasion of the micro-organisms, but that this rarely occurs.

PATHOLOGY.

We recognize four stages in the pathology of appendicitis; these Fowler has given as follows:—

1. *Endo-appendicitis,* in which there is more or less inflammation of the mucous membrane and sub-mucosa.

2. *Parietal appendicitis,* in which the inflammation attacks the interstitial or intermuscular tissue of the body of the appendix.

3. *Peri-appendicitis,* in which inflammation attacks the serous covering of the appendix, being limited by adhesions to that portion of the peritoneum between the appendix and the serous surfaces immediately adjoining.

4. *Para-appendicitis,* in which the inflammation attacks the tissues in relation with the appendix. In the last stage we find pus formation either localized by the limiting adhesions formed during the third stage, or general involvement of the peritoneum, etc.

It must be remembered that these stages are not marked by distinct lines of separation, because any one of them may be absent as a distinct stage, or, again, they may so merge into each other that it is impossible to distinguish between them.

In an attack of appendicitis, the primary condition is catarrhal inflammation. The changes are similar to those of inflammation of mucous membranes in general. We first notice a rapid shedding of the epithelium. The retiform tissue forming the groundwork of the mucous membrane becomes the seat of an infiltration of leucocytes; while many of the crypts of Lieberkühn become obliterated from the pressure exerted by the infiltrate. This is followed by destruction of the basement membrane and increase of the

leucocytal infiltration, the mucosa taking the form of a dense cellular layer with a raw internal surface. Numerous pockets containing degenerating remains of epithelial cells are seen (see case of Miss B——, Plate IX). In the lumen will be found leucocytes, granular debris, mucus, pus, etc., often molded into a definite mass by the muscular contractions of the organ.

The outcome of the attack depends upon several important factors: 1. Drainage of the organ. 2. The character and virulence of the micro-organisms present. 3. The presence or absence of fæcal concretions or foreign bodies.

If the appendix lies in such a position that gravity favors drainage, the products of the inflammatory process may be readily discharged, followed by amelioration of all the symptoms. If, however, the organ holds a position in which gravity opposes drainage, there may be retention of inflammatory products, with consequent increased inflammation. If the lumen remains unobstructed, the debris may be expelled by the peristaltic contractions of the organ. There is no doubt in my mind that the peristaltic contraction plays an important part in appendicitis, both as regards the causation and the result of an attack. In those cases in which drainage is perfect, we generally find apparent recovery, and the reverse is true if there is interference with the drainage.

The micro-organisms found in the first stage play a very important part in respect to the outcome of an attack, both by their species and by the virulence they individually possess. Thus, if the colon bacillus (*bacillus coli communis*) is present, unassociated with any other form, and if this bacillus is not virulent, the attack may terminate favorably. If we find the streptococcus present, we may look for a less favorable result. Generally speaking, the association of two or more forms of micro-organisms means a more rapid course and one of greater intensity.

Miss B., aged twenty years, was admitted to the hospital November 16, 1895, with a typical attack of acute appendicitis. Immediate operation was performed.

Operation revealed an acutely inflamed appendix which was very tense to the touch. The meso-appendix was also highly inflamed. The blood-vessels were engorged and prominent. After opening the appendix masses of débris, mucus, pus, and gangrenous tissue, having a very bad odor, were exposed. The mucous membrane was rough and presented nearly all shades of color.

Recovery rapid and uninterrupted.

Fig. 1

Inflamed
meso-appendix
Blood vessels

Fig. 2

Meso-appendix
Appendix opened
showing gangrenous
and purulent contents

The action of these micro-organisms is greatly influenced by the drainage of the organ, and by the presence or absence of fecal concretions or foreign bodies. If fæcal concretions or foreign bodies are present, they are liable to block up the lumen of the organ and thus induce the retention of inflammatory products. In this case the process will immediately proceed to the second stage, and attack the parietes of the organ.

If the appendix recovers after the catarrhal process has been in force, there will be a replacement of the destroyed mucous membrane by a tissue rich in cells. We often find a cicatricial condition in this healing process of the mucous membrane, that in places narrows the lumen of the canal, and at times obliterates the entire cavity of the organ. Ribbert makes the interesting statement that among 400 post-mortem examinations of the appendix, he found 99 (25 per cent.) in which there was partial or complete occlusion of the lumen of the appendix (see case of H. C. D., Plate X, also Plate XI). Of the 99 obliterations 16 were found to be total. There is in these cases generally a disappearance of the normal glands, and the walls of mucous membrane grow together, although the remaining layers of the organ remain normal.

As shown by the statistics of Ribbert, there may be in a small percentage of cases of disease of the appendix, if checked in the first stage, perfect recovery by the total obliteration of the lumen. This process of obliteration may begin at any point and extend in either direction until complete, or, as most frequently happens, it may start at the tip of the organ and proceed toward the base, in this manner expelling before it any inflammatory products.

If, however, the process begins at any point but the tip, we shall almost always find mucus and fæcal matter confined within a closed cavity. The results of this confined material

may be determined by one of several conditions. There is generally extension of the inflammation into the parietal layers of the organ, in which case it will burrow through the walls and cause perforation; or the mass may interfere with the circulation, thus causing gangrene and perforation (see case of C. J. E., Plate XI); or by pressure it may cause necrosis of the walls of the organ, ending in perforation. If the cellular tissue-layer that has replaced the mucosa is exceptionally dense, we shall find the material retained within the walls. As the amount of the débris increases, the walls of the appendix dilate to a remarkable degree and give to the organ various shapes, depending upon the number and position of the constrictions and upon the amount of débris contained within the lumen. In one instance I found the appendix distended to such an extent that I at first thought it was a small ovarian cyst. In this case the constriction was at the mouth of the appendix. In a second instance there was a constriction at the mouth and another about the middle of the organ, with an hour-glass-shaped bulging of the walls. In this connection the following case may be of interest:—

LARGE CYSTIC APPENDIX.

Miss C., twenty-five years of age, had had two attacks of appendicitis, the last being very severe and complicated by general peritonitis. Temporary recovery was secured under saline treatment.

Operation showed a cystic appendix the size of a small orange, and adherent both to neighboring coils of bowel and to the right broad ligament. The appendix was occluded at proximal end one-quarter of an inch from its cæcal attachment, and contained albuminous material.

Recovery was uneventful.

At times, instead of recovering, or instead of progressing into the parietal stage, the catarrhal state lapses into a chronic condition. There is marked infiltration, with decided thickening and rigidity of the walls of the organ, due to

CHRONIC APPENDICITIS.

H. C. D., physician, has presented the following report:—

On July 20, 1894, I was awakened by a feeling of discomfort in the abdomen, located chiefly around the umbilical region. It gradually grew worse until I had severe pain in this region. I took one-fourth of a grain of morphia, which gave me relief. I was able to get up and attend to my work two hours afterward. There was some soreness, discomfort, and tenderness on deep pressure over the region of the appendix. In four or five days I was feeling very much better.

I remained apparently well until September 20th, when I had a similar attack which was more severe and confined me to bed for six hours. Vomited freely, principally bilious matter. After being purged freely by citrate of magnesia I was relieved, but the soreness over the appendix remained for one week.

For three months I had perfect health and gained in flesh. On December 30th I had another attack, accompanied by severe pain and distress in abdomen; vomited freely without any relief. Stomach was irritable for thirty-six hours after this ceased. I took a dose of castor oil, which acted in four hours. After the first bowel movement I felt greatly relieved. Temperature ranged from 99° to 101½°. This attack was due to cold. After this attack I was not well. Had more or less soreness over the appendix, attended with obstinate constipation and dyspeptic symptoms. At times I had a great deal of pain in right testicle.

Was operated upon March 26, 1896. Recovery.

Fig. 1

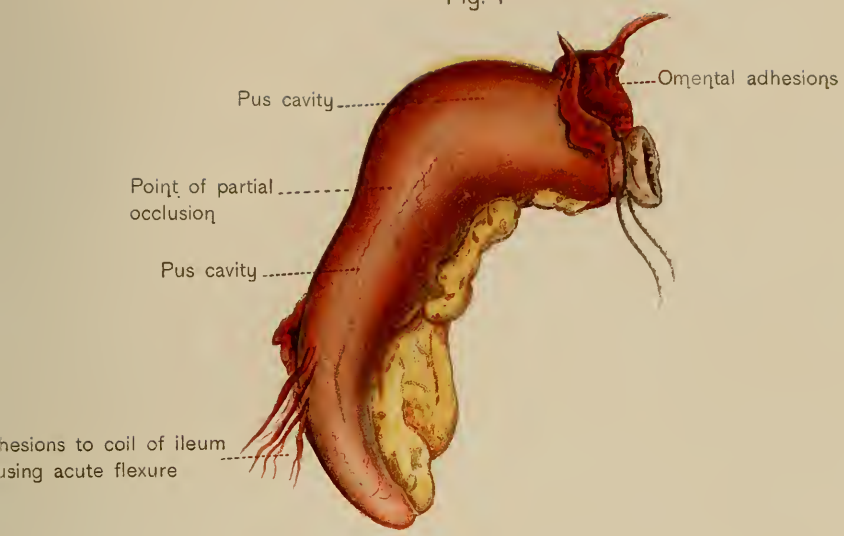
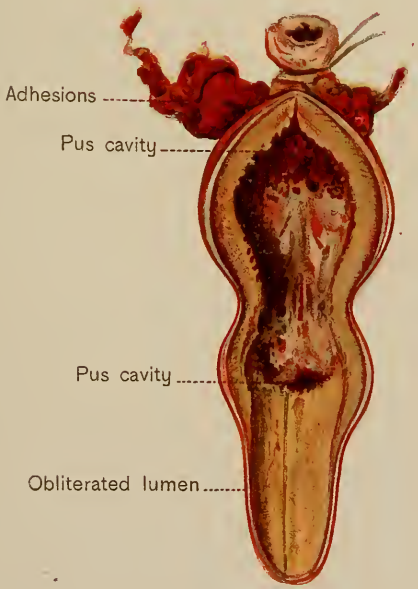

Omental adhesions
Pus cavity
Point of partial occlusion
Pus cavity
hesions to coil of ileum
using acute flexure

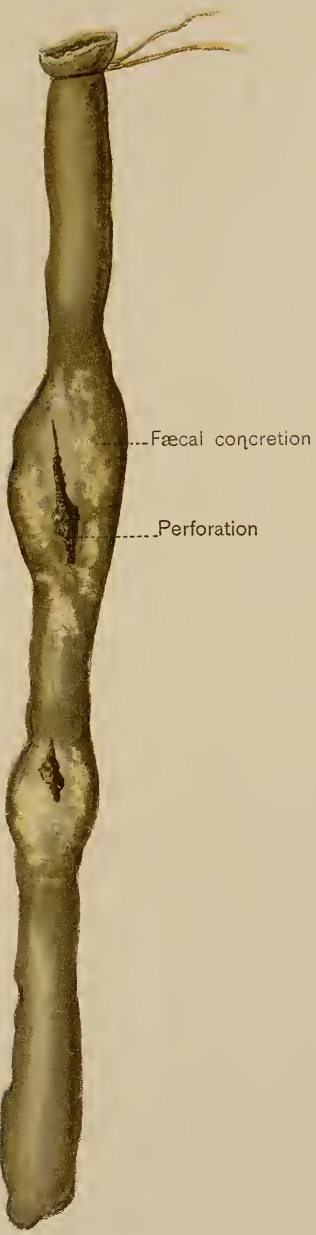
Fig. 2


Adhesions
Pus cavity
Pus cavity
Obliterated lumen

ACUTE APPENDICITIS.

C. J. E., age fifty-six, was taken suddenly ill on the evening of July 23, 1895, with severe abdominal pain. Examination by attending physician disclosed a distended abdomen and local tenderness in the right iliac region. Had pain with persistent tenderness over region of appendix. Gave a history of several similar attacks which had been treated as ordinary colic. The evening of the second day I saw the patient and advised operation, which was delayed for two days. Operation disclosed a very long and gangrenous appendix lying post-cæcal and post-colic; perforated; bathed in pus; contained several fæcal concretions. Pus in pelvis. Glass and gauze drainage were used. Recovery followed.

Remarks.—Patient the subject of chronic interstitial nephritis. For two days following operation vomiting and hiccough were persistent.


Fæcal concretion
Perforation

great increase of the fibrous element. This thickening and rigidity prevent the collapse of the walls, hinder obliteration, and interfere with peristaltic contractions of the organ, thus rendering difficult the expulsion of any inflammatory products present. The lining membrane continues as a pus-secreting granulation-tissue.

In the *second* stage of the disease, there is inflammatory involvement of the muscular walls of the appendix, with slight encroachment upon the serous covering. Although this may be induced by infection along the lymphatics without involvement of the mucous lining of the tube, it is generally secondary to the first stage. There is engorgement of the organ with deposit of exudate in the perivascular tissue. The appendix is enlarged, congested, and hard. We often find ulcers in the walls, caused by the pressure of the exudate in the interstitial tissues, extending into the lumen of the organ and by perforation soon communicating with the peritoneal cavity (see case of Mrs. R., Plate XII). These ulcerations may also be due to a necrotic process caused by the pressure of a fæcal concretion or foreign body. The concretions are generally soft and friable. They may harden, however, as the disease progresses, on account of the deposition upon their surfaces of lime-salts, usually the carbonate and the phosphate of lime. As the pressure increases, the epithelium, the mucous membrane, the submucosa, the muscular layer, and, finally, the peritoneum are in turn destroyed, and the pressing mass is expelled into the abdominal cavity. Perforation caused in this way, however, cannot always be ascribed to an ulcerative process, as evidences of inflammation are often absent. In these instances the destruction of the tissues is due to an atrophic condition produced by pressure.

Gangrene may be caused by interference with the circulation; by pressure; by strangulation due to twisting of the appendix,

or by embolism of the solitary artery or one of its branches. In this stage we often find a rapidly spreading phlegmonous inflammation due to the formation of pus, or, as demonstrated in the case reported on page 95, the pus may be collected in minute abscesses.

In this stage paresis of the appendix is often found consequent upon the inflammatory infiltration of its muscular coats. This paralysis interferes with the expelling force of the organ, and thus gives the débris and micro-organisms an opportunity to collect in the canal and hasten the process into the third stage.

In the *third* stage we find the peritoneal covering of the appendix severely affected. There are adhesions between the appendix and the adjacent serous surface, thus limiting the inflammation and, in case of pus formation, forming a barrier against infection of the general peritoneal cavity (see case of M. S., Plate XIII). If these adhesions are strong and plentiful, thus forming a firm wall around the inflamed area, we shall have the inflammatory process confined entirely to the right iliac fossa. The disposition of this wall of adhesions plays an important part in the subsequent treatment of the disease,—so far, at least, as the removal of the appendix is concerned. The adhesions may form between the cæcum and the adjacent coils of intestine and the parietal layer of the peritoneum (see case of Mrs. H., Plate XIV). In this condition the appendix will lie free in the enclosed area. In other states the appendix and part of the cæcum will be confined within the walls of adhesion (see case of M. T., Plate XV); or the base of the appendix may be outside the enclosed area, part of the appendix forming a portion of the wall and the rest emerging into the portion of the right iliac fossa that is shut in by the limiting membrane. In any of these instances, the proper procedure in the treatment is to remove the organ, even if the

CHRONIC APPENDICITIS.

Mrs. R., age thirty. Had always been rather delicate, but enjoyed a comparatively good degree of health except for a chronic intestinal dyspepsia of mild character with occasional exacerbations. In May, 1895, she had an attack of what was believed to be intestinal indigestion of more than usual severity, accompanied by diarrhœa and pain referred to region of appendix; recovered in a few days. December 7, 1895, she was suddenly seized with acute agonizing pain in abdomen, followed by rigidity of whole abdominal wall and diffuse tenderness. This condition yielded to the administration of laxatives and to hot applications locally. Nausea and vomiting, which at first were persistent, gradually subsided, with the tenderness becoming localized over the appendix. The temperature never rose above 102°.

On the tenth day a slight exacerbation of pain was caused by an indiscretion in diet. Two hypodermics of morphia were given in the course of the attack of pain, to quiet nervous excitement. Copious enemata were administered twice daily, and rectal feeding instituted until the stomach became quiet and retentive.

Although patient was recovering satisfactorily, operation for the removal of the appendix was decided upon and performed January 18, 1896.

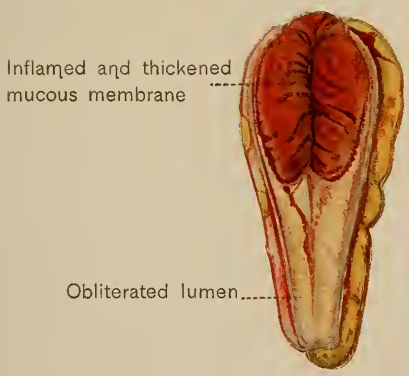
The operation showed the appendix enlarged, congested, and hard, and a point of beginning ulceration near the tip. Upon opening the appendix the mucous membrane at the base was found much inflamed and thickened, presenting superficial ulcerated areas. The lumen beyond the ulcerated part was totally obliterated.

The recovery was uninterrupted, and was followed by decided improvement of the old condition.

Fig. 1

Point of beginning ulceration

Fig. 2



wall has to be broken through, for in no other way can we assure ourselves that we have removed all chance of subsequent complications.

At this period there is marked engorgement of the perivascular tissues, swelling and hardening of the organ. We may find dark and soft necrotic patches containing within the tissues colonies of micro-organisms ready to perforate. Gangrene will often be noticed, due to interference with the circulation. In either the second or third stage, as will be explained later, we are likely to find necrotic or gangrenous patches in the meso-appendix, caused by obstruction of the circulation.

In the *fourth* stage, there is involvement of the para-appendicular tissues, associated with pus formation, which is due to direct invasion of pus through a perforated or gangrenous appendix, or to the spread of the phlegmonous inflammatory process along the contiguous tissues. If, during the third stage, the course of the inflammation has been slow enough to allow nature to throw a strong retaining wall around the affected area, we shall find the results of this stage limited by the boundary-membrane. Very often the process has been so rapid in its course that nature has had no opportunity to protect the surrounding structures, and the result is that we find involvement of the peritoneum, generally in the form of a purulent inflammation, with pus free in the peritoneal cavity and in the pelvis. If the pus is limited to the right iliac fossa we may have a period of apparent quiescence so far as any more extensive trouble is concerned, or we may find the pus burrowing in almost any direction, or ending in metastasis along the various lymphatic or blood channels. Thus, in the following case, the history of which has been furnished by Dr. O. Rath, the abscess had worked its way upward behind the liver and inward to the vertebral column.

November 25, 1895, I was called to see W. D. H., physician, thirty-one years old. He had been sick since November 22, 1895, suffering from a severe follicular tonsillitis. Previous history negative, with exception of an attack of pneumonia during childhood. At first visit he complained of severe pain over the stomach, nausea, loss of appetite, constipation, and violent headache. On examination found temperature 102°, pulse-rate 100, respiration 26. No action of bowels for two days; nausea, but no vomiting. The abdomen was much distended; severe pain on pressure over epigastric region, with slight pain and resistance on pressure in the right iliac fossa. Lungs and heart negative. Urine high-colored, slight amount of albumen, and a few granular casts.

November 26th and 27th, continuous vomiting of biliary matter. Vomiting was relieved by cocain and bismuth subnitrate. The bowels were moved by small doses of calomel. November 28th, vomiting ceased. Condition about the same, no pain in right iliac fossa, but pain over epigastrium as before. Temperature 101° to 102°, pulse-rate 90 to 110, respiration 24. Patient restless; no sleep except after injections of morphia sulph. Bowels moved only after the administration of calomel or glycerin enemata. This condition continued until December 7th, 4 P. M., when the patient had a slight chill followed by a temperature of 105°, pulse 150, respiration 40. At 9 A. M., December 8th, a second chill; temperature rose to 104°, pulse 130; three grs. quinine, and stimulants administered every two hours.

December 9th and 10th, chills, followed by profuse sweating. December 11th to 15th no chills, but slight sweating. Temperature from 101° to 102°. Condition otherwise the same; pain in epigastrium as before and over region of liver. December 15th and 16th, severe chills followed by sweating in afternoon; patient very restless, and had had no sleep for three or four nights. On examination, œdema and dilated veins over region of liver were noticed; pain in right iliac fossa upon deep pressure; pain over stomach the same. December 17th, Dr. J. B. Deaver in consultation. December 18th, patient was removed to the German Hospital.

Post-Mortem.—*Thorax.*—No effusion. Adhesions over right and left apices and left base.

Lungs.—An old tubercular lesion in left apex about the size of a walnut healed by fibroid calcareous changes. Congestion and œdema in remaining portions.

Heart.—Cloudy swelling of myo-cardium; no valvular lesions.

Liver.—Gall-ducts patulous. In removing liver and cutting through the suspensory ligament, there was a gush of purulent fluid apparently subdiaphragmatic. On further investigation there was found an opening in the upper back part of the right lobe. An abscess was discovered, about the size of an apple, occupying the right lobe and lobus quadratus.

Pancreas.—Normal.

Kidneys.—Cloudy swelling of parenchyma and cortex.

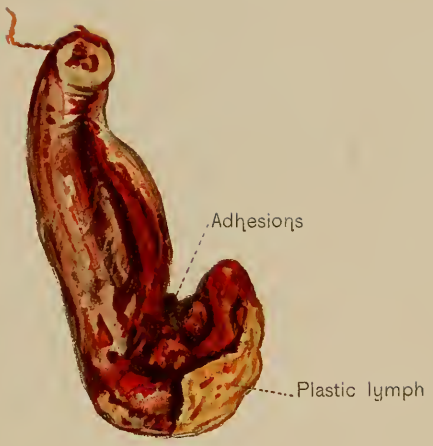
Appendix.—Appendix lay post-cæcal and post-colic, was perforated and surrounded by pus, which was in communication with the collection found behind the liver.

ACUTE APPENDICITIS.

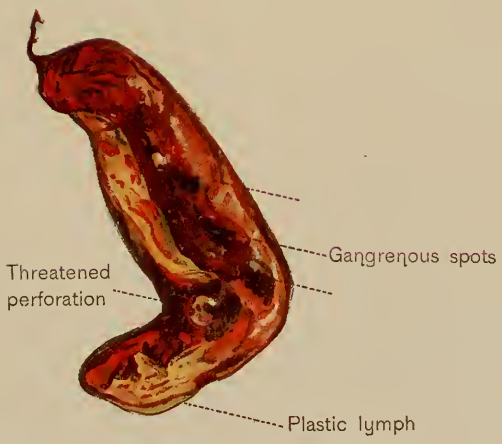
M. S., female, twelve years of age, was admitted to the German Hospital January 22, 1896. She had been ill six days with severe abdominal pains. The child was constipated; the attending physician ordered an enema; owing to continued pain, castor oil, and, later, salines were prescribed. The patient's condition not improving, the physician advised removal to the hospital for operation.

The appendix, post-cæcal, was bound down by adhesions. It was nearly perforated at various points and contained a small quantity of pus. The tissues were covered with a large quantity of lymph. There was no pus in the pelvis. Gauze packing was used.

Recovery followed.



Front view



Back view

In another case the pus had burrowed along the iliac vessels, and had presented on the anterior surface of the thigh, near the knee. If the appendix holds a southerly position we shall find the pus in the pelvis.

The lymph-spaces found in the lymphoid tissue and the lymphatic vessels of the appendix and the meso-appendix may become occluded by the exudate, or, together with the veins, they may become the channels through which septic infection takes place. Lymphangitis, from infection, may extend to the lymph-channels of the colon and mesentery and thus set up widespread inflammation. Following this condition we often find a general non-purulent peritonitis: the inflammation becoming purulent through invasion from the intestine brought about by the increased virulence of the micro-organisms.

The veins of the appendix are often the seat of thrombi, the result of infection, and in these cases we may find an extensive thrombo-phlebitis, pyle-phlebitis, portal embolism, and abscess of the liver. The last may be found in any stage of the disease, and often occurs in cases that are apparently too mild to attract attention to the original seat of the trouble.

The arterial supply of the appendix is often so interfered with that it gives rise to striking and interesting phenomena. The appendicular artery is the seat of a proliferating endarteritis, round sloughs forming at the openings of the arterial twigs, causing obliteration of their calibre. This brings about a gangrenous condition of the part supplied by the particular twigs affected. At times on account of a deficient blood supply the whole appendix sloughs. When the endarteritis does not cause total occlusion of the vessel, we find a slow ulcerative process in the parts supplied by the affected branches. The endarteritis present is caused by septic infection, the intima as a result undergoing rapid proliferation (Morris).

The infection may travel along the sub-peritoneal connective tissue and cause phlebitis of the veins of the lower extremity. Through this method of infection, we may find encysted extra-peritoneal foci of suppuration, the limiting walls being formed by adhesions due to infection.

The nerves of the appendix are affected by an acute inflammation during the progress of the disease, and the result of this nerve-complication may be found long after the symptoms of the attack have subsided. In the cicatricial condition following apparent recovery, we may have the nerve-fibres so pressed upon by the contracting tissues that they will be the cause of constant discomfort. Another cause of this condition may be the sclerosed condition of the nerves themselves, the interstitial connective tissue undergoing marked hypertrophy. I can recall cases in which the appendix had almost entirely disappeared, the remnant being but a fibrous cord, and yet the patient presented the marked pain and tenderness of chronic inflammation. The invalidism present was no doubt caused by this sclerosed condition of the nerves. The following case will illustrate this condition:—

On October 17, 1893, I. E. T., age fourteen, was taken with severe cramps in his abdomen. Similar attacks, but not nearly so severe, were always relieved by teaspoonful doses of paregoric. The attacks had always been produced by indiscretion in diet.

When seen the morning of the 18th he was suffering very much and complained of severe pain all over the abdomen, which was associated with general abdominal tenderness and decided rigidity of the abdominal walls, but more severe in the right iliac region. His stomach was irritable; he vomited dark-greenish fluid. Temperature 102°, pulse 120. Diagnosis, acute appendicitis with general peritonitis.

Minute doses of calomel were given which allayed the irritability of the stomach; this was followed by small doses of saline, when he was purged freely. Turpentine stupes and flaxseed poultice locally. He gradually improved from day to day, and in two weeks was convalescing. After the severe attack he always complained of soreness and discomfort in the region of the appendix. Palpation over this region never failed to elicit tenderness, though the appendix could not be made out.

CHRONIC APPENDICITIS.

In the following case the patient was the wife of a physician, and he has kindly furnished me with a detailed history and analysis of the treatment.

Mrs. H. early in April, 1895, had several attacks of abdominal pain accompanied by diarrhœa. (These attacks were not considered of any importance.) On April 28th, another severe attack came on suddenly at 2 A.M. At 10 A.M. she had excruciating pain, which, though general throughout her bowels, was particularly severe in the region of the navel and right iliac fossa. The pain finally became localized in the right side, and was accompanied by extreme tenderness, nausea, vomiting, and diarrhœa. Her physician gave her a hypodermic of morphia; had hot poultices applied and ordered small and repeated doses of calomel. The abdomen soon became distended; the pain and tenderness increased, and on palpation thickening and induration were detected. Appendicitis was diagnosed. Consultation was held as to the advisability of operation, but was not concurred in, as the consultant held that it was not a case of appendicitis, but ordinary catarrh of the bowels.

Discontinued the morphia and continued the poultices; and also $\frac{1}{10}$ grain doses of calomel, on account of the constipation which had followed the original diarrhœa. For the first week, there was little change in her symptoms, calomel kept the secretion in a liquid condition. After the first week she showed signs of improvement, but upon the slightest touch she complained of soreness, and the induration remained. Four weeks from the time of the last attack her condition was fair, and upon other advice operation was decided upon.

Operation: Parietal peritoneum not adherent. Mass of omentum covering and adherent to cæcum, which was deeply congested and infiltrated, resembling in appearance a cock's comb. Adherent omentum freed, tied off, and cut away. Cæcum exposed with small collection of foul pus post-cæcal. Appendix adherent to cæcum. Appendix liberated and tied off and removed, when perforation was seen both in cæcum and appendix, allowing the appendix to empty its contents into the cæcum. Margins of perforation in the cæcum freshened and the opening closed. Gauze drainage. Wound closed up to point of exit of drain with interrupted worm-gut sutures.

Recovery, though somewhat tedious, owing to a stitch abscess, was complete.

Appendix adherent to caecum

Appendix dissected off showing perforation into caecum

Perforation upon detached surface of appendix

ACUTE APPENDICITIS.

M. T., age twenty-one years, a theological student, was admitted to the German Hospital December 11, 1895. The first attack occurred one year before admission, characterized by severe pain in the right iliac fossa and vomiting. He was confined to his bed for five days. In June, 1895, he had another slight attack. One week before admission he was seized with violent, cramp-like pains and severe vomiting, with temperature 102°. Examination showed marked tenderness in the right side, rigidity, and swelling.

The operation, performed December 12, 1895, revealed an appendiceal abscess with considerable foul-smelling pus. The appendix pointed S. E., was imbedded in the abscess wall, and perforated near the middle. It was long, much thickened, and covered with plastic lymph ; it was about the size of an adult finger and very friable. Fæcal concretions were found in the abscess cavity. Gauze drainage was used.

Patient made a good recovery.

Operation the following May showed an obliterated appendix, with two small adhesions.

Recovery uninterrupted, with complete cessation of previous symptoms.

The interference with the abdominal sympathetic accounts for the neurasthenic condition which in some cases precedes or follows operation.

Any of these complications mentioned above,—thrombo-phlebitis, pyle-phlebitis, portal embolism, abscess of the liver, infective peritonitis, neuritis, lymphangitis,—prove that at any period there may be invasion through the lymph-spaces. Any of the stages may develop independently of the others, and in the course of the disease we may find the changes of one stage with little, if any, evidence of the other. This is accounted for by the various channels of infection.

Summary.

Four stages in pathology, but no distinct line of demarcation between them :—

1. Endo-appendicitis.
2. Parietal-appendicitis.
3. Peri-appendicitis.
4. Para-appendicitis.

The primary condition is catarrhal inflammation followed by microbic invasion. Outcome of attack depends upon :—

1. Drainage.
2. Character and virulence of micro-organisms.
3. Presence or absence of fæcal concretions or foreign bodies.

Cicatricial tissue prominent following catarrhal inflammation, but complete obliteration by it rare.

Ulceration of appendix walls frequent, and caused by interstitial exudate or pressure necrosis.

Gangrene due to :—

1. Interference with circulation.
2. Twisting of appendix.
3. Embolism of solitary artery or branch.

Paresis of appendix common and due to inflammatory infiltration of muscular wall.

Adhesions between appendix and adjacent serous surfaces limit pus collections.

In some acute cases there is not time enough for adhesions to form and pus is found free in the general peritoneal cavity.

Local and general infection, with suppurative foci in distant parts, as liver, takes place by means of lymphatic and venous channels. Nerve filaments of appendix are irritated by inflammatory exudate and cicatricial contraction and give rise to reflex pain.

Bacteriology.

Although the micro-organisms of appendicitis belong to a consideration of the ætiology of the disease, I prefer to describe them in connection with the pathologic changes they induce, as the part they play in the disease can be thus more readily understood.

Investigators have found about fifteen varieties of micro-organisms in the normal intestine of man, although only four of them are clinically prominent, viz.: the *bacillus coli communis;* the *staphylococcus pyogenes aureus;* the *streptococcus pyogenes;* and the *proteus vulgaris.* The micro-organisms line the intestine, being separated from the absorptive lymphoid tissue by a thin basement membrane.

The same condition is found in the normal appendix. In all investigations, the bacillus coli communis has been the one most frequently found, pure cultures of it having been made not only from the normal, but from the diseased intestine and appendix.

On account of its lessened vitality and its anatomic peculiarities, invasion of the appendix occurs more frequently than that of any other part of the intestinal tract. The appendix is a useless organ, undergoing retrograde metamorphosis, its powers of resistance being, necessarily, decreased.

Perforation
Pus cavity

The intestine, on the other hand, is always active, and if it is in a fairly normal condition, can resist almost any direct invasion. The appendix, moreover, is a dependent pouch, with a common entrance of ingress and egress, and is thus a favorable nidus for the collection and multiplication of germs, whether pathogenic or non-pathogenic. Anything that interferes with the drainage of the organ, either by obstructing the lumen or impairing the force of its peristaltic contractions, adds to the probability of infection.

The most important determining cause of an invasion by the micro-organisms is the existing virulence of the colon bacilli. The variability of the virulence of the bacillus coli communis is probably greater than that of any other known micro-organism. Why this is so, what it is that causes this change in the virulence of the germ, is not understood, but that it is so is clearly demonstrated in the pure test-tube cultures, the growth in some being much more active than in others; while inoculations from the different tubes show decided differences in degree of virulence. If the colon bacillus is non-virulent the appendix may possess the resistant power required to overcome its action; but if this bacillus is virulent, the resistant strength of the appendix will be of little account. Hodenpyl, in an investigation of 61 cases of peritoneal inflammation consequent upon appendicitis, obtained the colon bacillus in 57 cultures, and in 50 of these it was unassociated with any other germ. In cases of mixed infection, we generally find the staphylococcus or the streptococcus associated with the colon bacillus, the latter combination being much more intense in its action.

The character of the attack depends, to a great extent, upon this infection; upon the power of resistance possessed by the organ at the time of the invasion; upon the condition of the lymphatics and blood-vessels; and upon the condition of the

muscular coats of the organ. We may, however, have just as severe cases in which the bacillus coli communis is the only factor in the causation. If the lymphatics, blood-vessels, and muscular fibres are in a healthy and active condition, there is less liability of a severe attack, as the appendix will be enabled, at least to some extent, to check the disease. If the opposite conditions prevail, the micro-organism will have full play, and the severity of the attack will be correspondingly increased. Thus, if we have the débris of mucus, and fæcal matter retained within the appendix, or if fæcal concretions are present, there will necessarily be a greater degree of inflammation and a more rapid course of the disease.

As before mentioned, the outcome of the micro-organismal invasion will be modified by the freedom of drainage to a greater extent than by any other factor. At times the layer of cellular tissue that replaces the mucous membrane is so dense that it resists the invasion of micro-organisms, but dilates under the increased pressure caused by the contained action of the germs, and in such cases we find the hour-glass-shaped bulging of the walls of the appendix, or, if the obstruction be at the entrance to the canal, the ballooning of the whole length of the organ.

The micro-organisms of typhoid fever, of tuberculosis, and of actinomycosis have been found in the appendix, but their presence in this locality is rare.

SYMPTOMS.

In considering the symptoms of appendicitis, it must be borne in mind that it is not always possible to determine the pathologic change by the apparent symptoms. Any attempt to describe symptoms which positively indicate the progress of the disease would be futile. While it is true that the symptoms become more marked when perforation, pus formation, or gangrene supervene, it is also a fact that remission of all the symptoms, except local tenderness, may occur, and yet the disease may be progressing steadily to a fatal termination.

I shall speak of two forms of appendicitis, the acute and the chronic.

The acute form embraces those varieties described as ulcerative, perforative, and gangrenous. These terms represent only the differences in the degree of local inflammation, between which it is clinically impossible to draw a line of distinction. It, therefore, appears more practical to describe them under one collective heading. The same is true of chronic appendicitis, under which heading are included the varieties described as subacute, relapsing, and recurrent.

There are three symptoms of appendicitis so constant, and, when associated, so characteristic of the affection, that I style them the "Three Cardinal Symptoms;" these are pain, tenderness, and rigidity, each of which I will describe in detail.

Pain is the initial symptom, and usually follows the ingestion of foods, either indigestible, improperly masticated, or hastily swallowed. At the onset, the character of the pain

is paroxysmal and colicky, to this extent simulating an attack of acute indigestion or bilious colic. The term appendicular colic has been applied to this initial pain, but to this name objection has been raised, since the cause of pain is inflammatory and not functional. While acknowledging such to be the case, I am, nevertheless, convinced that the pain may be paroxysmal because otherwise it is difficult to explain the wave-like exacerbations, so vividly described by intelligent patients.

Palpation over the affected area, motion involving the action of the right psoas muscle, bending the body to the left, deep inspirations, or coughing,—all these excite and intensify the peculiar, undulating, characteristic pain. As the pain is partly due to appendiceal inflammation, its general colicky character is probably the result of irritation, reflected along the numerous branches of the superior mesenteric plexus of the sympathetic, one of which supplies the appendix. This irritation is held to be the result of the presence of fæcal concretions or foreign bodies. I cannot think that the mere presence of these substances will account for the irritation, as we are compelled to acknowledge the fact that such are found in many normal appendices. And again, we have attacks of this colic due to disease of the appendix, in which the lumen is entirely free from all concretions. In its efforts to expel material from its canal, the peristalsis of the appendix has been given as a definite cause of this irritation, but I cannot entirely agree with this view, because of the fact that, without any such symptoms, the normal appendix empties itself during health. I believe, however, that the paroxysms of colic are largely due to the erratic peristalsis of the inflamed appendix, induced by the effort to rid itself of foreign material. Fowler has taken exception to the term appendicular colic, offering as an argument against it the fact of the imperfect

development of the circular muscular fibres of the appendix, whence its inability by expulsive efforts to cause colicky pain. I cannot agree with this view, and particularly as regards the absence of circular muscular fibres, as this organ possesses a continuous circular muscular coat. I grant that the circular muscular fibres are not always so well developed as the longitudinal ones, but I am convinced that the appendix usually possesses sufficient contractile power to cause colicky pain by muscular contraction. The study of pathologic appendices cannot be relied upon to demonstrate normal histologic facts. The dissection of normal appendices proves the presence of circular muscular fibres. The irritation, arising from simple catarrhal inflammation of an appendix, in which there is no fæcal concretion or foreign body, is capable of inducing expulsive efforts that cause colicky pain, just as in an inflamed rectum or bladder. Under such circumstances, the presence of a foreign body serves merely to intensify the pain.

The Location of Pain.—As described by the patient, the primary pain is most frequently referred to the umbilicus or peri-umbilical region; next in order of frequency to the epigastrium; and last of all to the region of the appendix. In fact, the pain of appendicitis may be referred to any portion of the abdomen. And this it is that has led to so many mistakes in diagnosis. After the occurrence of localized peritonitis in the right iliac fossa the pain is there located. Not infrequently it is referred to the left side of the abdomen.

The location of the secondary pain to a large extent depends upon the position of the appendix. If the appendix is long, with its tip overhanging the brim of the pelvis, the pain will be referred to the left side of the abdomen, along the course of the spermatic cord toward the testicle, or to the pelvis. If the appendix is post-cæcal and pointing north, the pain may be

referred to the loin or back; at times, if the appendix points north, lying either in front or back of the cæcum, the pain may be referred to the kidney or to the liver. As a rule, the pain will be more marked in the right iliac fossa. If, however, the tip of the appendix occupies the left iliac fossa the greatest amount of pain will be referred to that region. In a certain class of chronic cases the pain which is increased on motion may be referred to the leg along the course of the anterior crural nerve or even to the knee. This occurs when the appendix occupies the pelvis.

The Character of the Pain.—Too much stress cannot be laid upon the paroxysmal nature of the initial pain. In fact, I have seen numerous cases in which this has been attributed to biliary or nephritic colic, being quite as severe as in those affections.

Tenderness upon pressure is one of the most valuable and constant of all the signs of appendicitis. It is always present. If the appendix is post-cæcal and the rigidity of the abdominal walls marked, the tenderness is more difficult to elicit, and requires deep palpation. It is sometimes best elicited through the rectum or vagina. In women the possibility of a right-sided pyo-salpinx or salpingitis must also be borne in mind. In rare cases the tender spot may be located in the loin, and discovered only by deep palpation. After the advent of suppuration with the increased amount of pus the tenderness in the right iliac fossa becomes more general. Frequently after the remission following the sudden, sharp primary attack, tenderness and rigidity alone remain to tell the attending physician that trouble still exists. The point of greatest intensity is usually over the inflamed appendix, but to this rule there are exceptions. Recently in a young adult male I found the point of greatest tenderness to the left of the left rectus muscle, a little above the level of the anterior superior spine

of the ilium. By rectal examination a small but very sensitive mass was detected occupying the recto-vesical space. Operation demonstrated the appendix occupying this position. The point of greatest intensity, however, usually corresponds to the so-called McBurney's point, which is located midway between the umbilicus and the right anterior superior iliac spine.

I recall two cases in which the point of greatest tenderness was immediately above the middle of Poupart's ligament. This, as demonstrated by operation, corresponded to the angle of curve in the appendix; in both cases the origin was from the postero-external aspect of the base of the cæcum, descending in front of the latter as far as the apex, where it abruptly curved upward.

Rigidity of the Abdominal Walls.—Next to pain this is one of the most reliable signs. It is usually confined to the right side of the abdomen, is most marked over the inflamed region, and immediately follows the localization of pain in this locality. In some instances the rigidity is so pronounced that it prevents deep palpation, and in addition makes the percussion-note of higher pitch. When the pain has been referred to the left side and suppuration has supervened, the pus collection occupying the pelvis, there will be marked bilateral rigidity of the recti muscles and of the lower abdominal wall.

Although the "three cardinal symptoms" are the most important indications of appendicitis, there are others presenting themselves with more or less regularity. Among these should be noticed disturbances of the gastro-intestinal tract, elevation of temperature, increase of the pulse-rate and of the respiration, abnormality of the urine, etc.

Vomiting.—Coincident with the onset of the initial pain there may be vomiting. In favorable cases this usually does not persist, and subsides with the localization of pain in the

right iliac fossa; in unfavorable cases it is continuous and uncontrollable. The ejecta consist first of the gastric contents, later of bile, and lastly, if intestinal paresis has followed a septic peritonitis, of stercoraceous matter. When the vomitus becomes stercoraceous, it is thrown off by regurgitation, and indicates a fatal termination. Nausea and vomiting may sometimes be absent.

Constipation.—In the majority of cases of appendicitis constipation is present, but diarrhœa sometimes ushers in the attack, particularly in those cases which from the onset bear an unfavorable àppearance. Obstinate constipation early in the disease is due either to intestinal paresis, the result of infection, or to the indiscriminate use of opium. Although these conditions seem to play but little or no part in the causation of an attack, the bowels being previously in a normal condition, yet, as soon as infection takes place, there is almost always a decided change. This constipation, with vomiting, has in the early stage of the disease led to many errors in diagnosis, the affection of the appendix having been mistaken for acute strangulation or some other form of intestinal obstruction. The constipation is probably due to reflex paralysis of the large bowel.

The temperature and the pulse-rate bear no direct relation to the gravity of the attack. At the onset there is usually an elevation of temperature varying from 100° to 102° or 103° F. We may have early perforation and gangrene of the appendix with but a moderate rise of temperature; on the other hand, there may be a decided rise with a simple catarrhal inflammation. The pulse in the former class, *i. e.*, those with early perforation and gangrene, more nearly corresponds to the gravity of the attack. A sudden fall of temperature to the normal or subnormal by no means warrants a favorable outlook, as it too often indicates the lull immediately preceding the storm of

destruction, perforation, or a ruptured abscess. The thermometer is, therefore, a most unreliable instrument as an indicator of the gravity of an attack.

Restlessness.—Marked restlessness occurring in the course of an attack, especially in children, denotes the presence of pus.

Tumescence.—In a few cases there will be a bulging of the right iliac region not due to distention of the bowel. This is not frequently observed unless an abscess is present.

Abdominal distention may be due to several causes: to mechanical obstruction by bands of adhesions; to paralysis of the intestine; to septic causes; to obstinate constipation with resultant collection of gas. Richardson points out the possible differential diagnosis, by means of auscultation, between distention due to accumulated gas and that due to paralysis of the intestine the result of infection, the sounds of peristaltic action being clearly heard in the former condition but not in the latter. The distention may sometimes be limited to the right side of the abdomen; in this condition only that portion of the gut contiguous with the inflamed area is affected. This local distention may be marked, because the still functionally active intestine will force more gas into the affected portion. If peritonitis becomes diffused, the abdomen, though generally distended, is sometimes flat with its walls rigid and hard, a condition appearing early and arising from the complete paralysis of the intestinal canal, which prevents the entrance of gas. A distended abdomen, or one in which the distention is particularly marked over the epigastrium, either condition being associated with persistent and uncontrollable vomiting, is a combination pointing to an unfavorable termination.

The tongue is furred, and if diffuse peritonitis occurs, may become dry; and associated with a deposit of sordes upon the teeth. In severe types the tongue is fissured.

The Urine and the Bladder.—The urine is usually diminished in amount, and often contains albumin and indican. Several theories have been advanced to explain this diminution in quantity and presence of albumin in the urine. The most tenable of these is that there is decreased activity of the glomerules of the kidney, due to the general fall in arterial tension. From the first, frequency of urination is often a prominent symptom and is probably due to disturbance of the sympathetic nerves, and, when an inflamed appendix occupies the pelvis, to a directly communicated irritation of the bladder. In peritonitis involving the serous coat of the bladder, retention of urine may occur, necessitating the use of the catheter. It is uncertain what influence inflammation of the appendix may have upon the function of the kidneys, but experience has taught me that acute and subacute nephritis is of frequent occurrence. Whether the two conditions exist in the relation of cause and effect I am not prepared to say. Theoretically the causal relation would not appear to exist, but as practice and theory are so often totally different it must, until further demonstration, remain an open question. I have records of numerous cases in which there were present blood, granular, compound granular, and hyaline casts, with albumin, and a marked diminution in the amount of urine secreted, in most of which the urine became perfectly normal during convalescence. This observation is purely clinical and, like many such, must stand as true. It may be that the sympathetic system, as it is in other intra-abdominal inflammations, is responsible, although not to the same extent as in appendicitis.

Respiration.—Respiration plays a comparatively unimportant part in the symptomatology of most cases of appendicitis, although early in the attack there is a voluntary limitation in breathing, the patient favoring costal respiration. If the distention is pronounced, the respiration is correspond-

ingly labored, while if there is active peritonitis the respiration is thoracic. In advanced cases of appendicitis with a diffuse peritonitis, I have noticed a peculiar reflex condition of the pharynx, described by the patient as a difficulty in swallowing. Very rapid respiration due to septic absorption becomes a grave symptom, as in a very large percentage of such cases it indicates pulmonary involvement.

Leucocytosis, according to Richardson, is an invariable symptom in perforative appendicitis. I cannot, however, consider it of any marked value, as the condition of the appendix will demand its removal long before leucocytosis can be demonstrated.

Palpation of the Appendix.—During an acute attack there will, as a rule, be such marked tenderness over the region of the appendix that it will be practically impossible to palpate the diseased organ. Moreover, in the acute stage of the disease, the rigidity of the abdominal walls will also hinder proper palpation. The method described by Edebohls is, therefore, of little value, although in the diagnosis of chronic appendicitis it plays a most important part. I shall, therefore, describe his method when considering the symptoms of the latter affection.

Chronic Appendicitis.—The symptoms of chronic appendicitis are more variable than those of the acute affection. The most constant of all is pain, which is usually confined to the right iliac fossa, is subacute in character, and varies with the condition of the general intestinal tract.

If there is exudate with adhesions, and especially if a portion of the great omentum is involved, *palpation* will demonstrate more than if the appendix alone is affected. In chronic appendicitis, palpation reveals an enlarged and inflamed appendix, with more or less tenderness, the severity of which depends upon the presence or absence of pus. Edebohls

describes his method of palpating the appendix in women as follows: "After completion of the ordinary bimanual examination of the pelvic organs, the patient is drawn upward upon the table about a foot, her feet still remaining where they were placed for the vaginal examination. This is mainly for the purpose of unfolding the flexure of the thigh upon the abdomen, and to render the right iliac region more accessible to the palpating hand. One hand only, applied externally, is required for the practice of palpation of the vermiform appendix. No assistance can be rendered by a finger introduced into the vagina, and very little assistance, and that only occasionally, by a finger introduced into the rectum. Standing at the patient's right, the examiner begins the search for the appendix by applying two, three, or four fingers of the right hand, the palmar surface downward, almost flatly upon the abdomen, in a straight line from the umbilicus to the anterior superior spine of the right ilium. He notices successively the character of the various structures as they come beneath and escape from the fingers passing over them. In doing this, the pressure exerted must be sufficiently deep to recognize distinctly, along the whole route traversed by the examining fingers, the resistant surfaces of the posterior abdominal wall and of the pelvic brim. Only in this way can we positively feel the normal, or the but slightly enlarged appendix; pressure less than this must necessarily fail." Not infrequently such examinations excite an acute exacerbation from the irritation produced by the manipulation.

If the tenderness and pain are marked, we shall usually find pus encapsulated either within the appendix or between the layers of the meso-appendix. Associated with the presence of the chronically inflamed appendix there are evidences of intestinal indigestion, discomfort, of pain increased by exertion and referred particularly to the right

iliac fossa, and mucous diarrhœa alternating with constipation. There is indisposition and general debility. Neurasthenia is often an associated condition. Exercise or undigested food, by increasing peristalsis and thus pulling upon the adhesions, frequently cause exacerbations of pain. Fever is of importance only when of the hectic type.

Summary.

No distinct relation between symptoms and pathologic change.

Acute Appendicitis:—

1. Ulcerative.
2. Perforative.
3. Gangrenous.

"Three cardinal symptoms:"—

1. Pain.
2. Tenderness.
3. Rigidity.

Pain usually appears after eating; at first is colicky and referred to epigastrium; later becomes localized usually to site of appendix.

Tenderness is always present, sometimes best elicited by rectal or vaginal examination.

Point of greatest tenderness usually over appendix.

Rigidity usually right sided; follows localization of pain and is most marked over inflamed area.

Vomiting common at onset of attack. Desists in favorable cases; its prolongation is a serious symptom.

Chronic Appendicitis.—History important. Palpation most valuable means of diagnosis.

Localized pain and tenderness most constant symptoms.

DIAGNOSIS.

The diagnosis of appendicitis is, ordinarily, quite simple. When the three cardinal symptoms are present, viz., sudden onset of acute abdominal pain, with or without vomiting, occurring in one previously well; unilateral rigidity of the lower abdominal wall; tenderness over the site of the appendix,—the diagnosis of appendicitis is unexceptionally warranted. That the diagnosis is not always made may be variously accounted for, but chiefly by the still-lingering picture of an inflamed cæcum, its lumen filled with fæcal matter, and general inflammation surrounding the organ,—the appendix being placed far in the background, so far, in fact, that absolutely no significance is attached to its condition. If, from the mental picture, the cæcum could be entirely removed, and in its place be put an inflamed and angry appendix, mistakes in diagnosis would be of less frequent occurrence.

Failures in diagnosis may often be explained by the fact that the initial symptoms are lost from sight, or have been entirely concealed by the injudicious use of opium. The ushering in of an attack of appendicitis very closely simulates acute indigestion, with the same vomiting, colicky pains, often extending over the entire abdomen, and soreness of the abdominal walls. In appendicitis, however, the general abdominal pain soon becomes localized in the right iliac fossa, when we should at once suspect the presence of more serious trouble than simple indigestion. The tenderness on pressure also becomes localized, the point of greatest intensity usually corresponding to the position of the inflamed organ. This

tenderness is one of the most important and constant signs on which to base a diagnosis. It is always present, and may be elicited by simple pressure of the tip of the finger. As a rule, there is a distinct relationship between the degree of tenderness and the degree of inflammation. Although the point of tenderness generally corresponds to McBurney's point, much depends upon the position of the appendix, whether it be anomalous or otherwise. It is here that the value of a rectal or vaginal examination must be remembered.

If the appendix holds a southerly direction, and overhangs the brim of the pelvis, the point of greatest tenderness will be found by rectal or vaginal examination, although, except a sense of fulness, nothing else by such means will be demonstrated. In these cases, one may err by the fact that, when palpating the abdominal wall, no especial point of tenderness will be found there; but either a rectal or a vaginal examination, or a combination of the two, must, nevertheless, be made, whereby a point of marked tenderness will often be detected.

The point of greatest tenderness may be immediately above the middle of Poupart's ligament, or to the left of the linea alba, or in either the lumbar or hepatic regions, the location depending upon the position of the appendix and the site of the inflammation.

In acute cases, it is usually not at all difficult to elicit tenderness. When asked where the greatest intensity of pain is located, the patient himself will, almost invariably, direct our attention to the appendix; palpation over this region will elicit tenderness, while wave-like exacerbations of pain are provoked. In chronic cases, it may be more difficult to locate the tenderness, but deep, firm pressure will rarely fail to provoke flinching and pain, thus demonstrating the presence of a diseased organ.

Between the extent of the disease and the degree of tender-

ness there is generally a close relation. As a rule, increase of tenderness denotes a progressive inflammation, while decrease of tenderness, accomplished without the administration of anodynes, usually indicates a favorable course.

If pus is present, the degree of tenderness will be so great that no difficulty should be experienced in localizing the point of greatest intensity. If, however, septic absorption has progressed so far that paralysis of the nerve-filaments has been caused, we may find that the tenderness has almost disappeared, and this without a corresponding diminution in the progress of the disease. Under such circumstances, the other signs will be so marked that there should be no difficulty in reaching a diagnosis.

With few exceptions, localized tenderness will increase according to the development of the disease. Thus, the formation of pus gives rise to excruciating pain; over an appendix undergoing gangrenous change the tenderness is marked; perforation, with the formation of a large abscess, causes increased tenderness, although this may not be so decided as in those cases wherein a small abscess is confined to the lumen of the appendix, or to a small area of the meso-appendix. If the peritoneum becomes generally infected, the tenderness will be more widespread, and may extend over the entire surface of the abdomen; at first general, or more or less confined to the umbilical or peri-umbilical region, the pain, as the disease continues, becomes more localized, generally to the right iliac fossa.

The position of the pain will vary with the position and direction of the appendix. Thus, in cases in which the appendix points north, the pain may be referred to the lumbar or hepatic regions. In certain cases, the pain is referred entirely to the left side, although this does not, as a rule, indicate that the appendix points east, as in these instances it

more generally points south, and occupies the pelvis. This fact should be emphasized, as I have seen a number of examples in which the attending physicians, who were familiar with the general symptoms of appendicitis, were totally misled. The citation of one case, that of the son of a physician, will serve to illustrate the importance of pain referred to the left side as indicative of the pelvic position of the appendix.

Master A., shortly after a meal of indigestible food, was suddenly seized with acute abdominal pain, vomiting, and rigidity of the right lower abdominal wall. Symptoms of acute peritonitis developed in three days, at which time the father consulted me, saying that he would have regarded the case as one of appendicitis had not the pain been referred to the left side. I told him that in my opinion the disease was appendicitis, and that operation was immediately demanded. Two days later I was hastily summoned to see the boy, whom I found suffering from a diffuse peritonitis of an active type, the pulse-rate 130, with a "leaky" skin, and constant retching and constipation. I declined to interfere except to advise total discontinuance of opium or any of its preparations, and ordered, instead, small, repeated doses of calomel to the extent of free purgation. I believed this a wiser course to pursue than to operate. Apparent recovery followed. I then advised operation in order to prevent recurrence, but the father could not agree to have his son operated upon when in apparent good health. Within ten days a second attack occurred; I was again summoned, but being absent from home, other counsel was sought; operation was again deferred, resulting in a second incomplete recovery. Again I was consulted, and as before I advised operation, which this time was consented to. The appendix, the tip of which contained a pus-collection, and the whole surrounded by an encysted abscess, was found occupying the pelvis, adherent to its floor and to the right of the rectum. The appendix was removed and recovery was uneventful.

In those cases, therefore, in which the pain is referred to the left side, with the point of greatest tenderness immediately above the pubis, or in the left iliac fossa, the greatest intensity of the inflammation will be confined to the tip of the appendix. It is in the class of cases in which the appendix occupies the pelvis that vesical symptoms, such as irritability, frequent micturition, and retention, are, from a diagnostic standpoint, of value.

The abrupt cessation of pain previously located in the region

of the appendix, followed by a fall of temperature, increased pulse-rate, and an anxious expression, are symptoms which indicate the occurrence of gangrene.

From experience in operating upon a number of cases in which the appendix invariably pointed south, I am prepared to say that when pain is referred to the left side, the appendix occupies the pelvis. Also, that when in these suppuration has taken place, resulting in a large pelvic collection, bilateral rigidity of the abdominal wall is always pronounced. When I am asked to see a patient, the diagnosis of whose ailment is not clear, with a history of the three cardinal symptoms, with the pain referred to the left, rather than the right side, with a temperature denoting a hectic condition, and with a bilateral rigidity of the lower abdominal walls, I am convinced that it is one of suppurative appendicitis, in which both the pus collection and the appendix occupy the pelvis. An illustrative case is the following:—

During the past summer I was asked to see Miss ——. About two weeks previously she had been suddenly attacked by what was at first supposed to be acute indigestion, which, however, did not yield to the ordinary remedies. In view of the fact that the spleen was enlarged, characteristic spots present, and the temperature suggestive of an irregular type, a provisional diagnosis of typhoid fever had then been made. But the suddenness of onset, accompanied by acute abdominal pain, with decided bilateral rigidity of the lower abdominal walls, the temperature-record, the vaginal and rectal examinations, which excited great pain, with the characteristic fulness, stamped the case one of suppurative appendicitis with a pelvis full of pus. I advised immediate operation. Adverse opinion of other counsel caused a delay of two days, when upon operation a large collection of foul pus was found, the appendix, which was perforated and gangrenous, occupying the pelvis. The appendix was removed and recovery was uneventful.

Under these circumstances rectal or vaginal examination will demonstrate a sense of fulness. The contrast between this condition, and that of suppuration in the pelvis dependent upon infection of any of the uterine appendages, will be discussed later.

In almost all cases of appendicitis there will be more or less rigidity of the lower abdominal walls. Simple pressure with the tips of the finger will demonstrate it. In the majority of cases it will be found more marked over the right iliac fossa; in others, if the pain is referred to the left side, the rigidity will be more pronounced there. When the appendix occupies the pelvis, and is the seat of a pus collection, there will be bilateral rigidity.

Fulness.—In the early period of the affection, little, if any, fulness in the right iliac fossa is observed. It appears late in the course of the disease, after inflammatory exudate has been thrown out and adhesions have been formed. In connection with this fulness, there may be a doughy feeling, or even œdema, both of which may be indicative of pus, although excessive tenderness is a more reliable sign. Œdema of the abdominal walls, with symptoms of another disease, may lead to the false impression that the seat of the trouble is not in the appendix, as is shown by the subjoined instance:—

Miss H. was attacked ten days prior to examination. She had had the usual symptoms of acute appendicitis, but owing to slight jaundice, and decided œdema of the parts overlying the hepatic region and the lower right chest, there was some doubt in the mind of the attending physician as to the location of the inflammatory process. Upon pressure there was more pain over the œdematous area than over the normal position of the appendix. After considering the character of the symptoms from the beginning of the attack I concluded that purulent appendicitis was present, and that the organ was located post-cæcal, pointing north. Operation confirmed this diagnosis. The appendix, gangrenous and separated from the cæcum, was post-cæcal and surrounded by a collection of pus extending upward behind the liver and inward to the vertebral column. Recovery followed.

With the development of any fulness or bulging, the contour of the abdomen becomes asymmetrical. The bulging may at times be found to the outer side of the right rectus muscle, caused by a distended cæcum floating over an encysted abscess; or at times fulness will be found above the outer half

of Poupart's ligament, due to the presence of pus, exudate, or inflated bowel.

Late in the attack I have noticed a prominent, rounded swelling immediately above the symphysis pubis; operation has proved this to be a collection of pus.

Distention.—In the beginning of an attack of appendicitis there is little, if any, distention, and in favorable cases the disease may terminate with no distention whatever. Generally, however, in the later stages of the disease, we find either localized or general distention. It may be caused by mechanical obstruction of the bowel, by adhesions, or by kinking of the bowel itself. Localized distention is due to a localized peritonitis, with paralysis of the bowel in the affected portion. When distention becomes general, and is not due to mechanical causes, it probably results from paralysis caused by irritation of Auerbach's plexus, or from a general peritonitis. Marked constipation and the use of opium also cause distention, and thus hinder recognition of the true condition. By auscultation, we may generally distinguish functional from paralytic distention, peristaltic rumblings being heard in the former but not in the latter variety. In cases of profound septic infection, consequent upon a purulent peritonitis, we may, at times, find a scaphoid condition of the abdomen due to complete paralysis of the bowel.

The Presence of a Tumor.—In many cases it is impossible to determine the existence of tumescence, owing to marked rigidity of the abdominal wall and excessive pain; rigidity, however, should never be mistaken for a tumor. Although it has been claimed that a tumor can be found in every case of appendicitis, such is not my experience. The cæcum is never the seat of a collection of fæces, and this fact, together with the knowledge that the appendix is not much enlarged at the onset of the attack, is sufficient in most cases to disprove the

presence of a tumor. After the disease has somewhat advanced, with exudate and adhesions present, a distinct tumescence may usually be diagnosticated by palpation. But if the appendix hold the pelvic position, abdominal palpation will, with few exceptions, fail to reveal any tumor whatever. In these cases a rectal or vaginal examination may be the means of discovering a mass. When the appendix is located in the abdominal cavity, its position can generally be determined, especially if the disease has progressed so far as localized peritonitis. Thick abdominal walls or the destruction of the anatomic relations by excessive tympanites might cause some difficulty. Another condition that might hinder the location of an appendiceal mass would be a post-cæcal position of the appendix, with rigidity of the abdominal muscles and distention of the bowel.

The presence of inflammatory exudate presents to the palpating fingers a hard, unyielding mass, which I believe has been frequently mistaken for an accumulation of fæces in the cæcum.

It is exceptional for a *chill* to mark the advent of pus-formation in appendicitis—this, despite the widespread belief among physicians that the absence of a chill precludes the possibility of suppuration.

Coincident with the onset of an acute attack there is always a rise of *temperature*, similar to that observed in all acute septic conditions. This is more marked in children. In the diagnosis of appendicitis, however, the temperature is so variable that, except in making a differential diagnosis, it is, as a guide, of little value.

The Respiration.—As a rule, the breathing, in acute appendicitis, becomes shallow or even thoracic, and, if general peritonitis supervene, is markedly so. An attempt to take a full, deep breath causes severe pain, clearly showing itself by the expression of the face.

Sudden contraction of the abdominal walls, consequent upon an effort to cough, will excite pain over the affected area.

Summary.

Diagnosis, "three cardinal symptoms," viz.:—

1. Sudden acute pain in one previously well.
2. Unilateral rigidity of lower abdominal wall.
3. Tenderness over site of appendix.

After onset, tenderness on pressure soon becomes localized and corresponds approximately to degree of inflammation. Location of tenderness usually over McBurney's point, but varies with position and condition of appendix.

Rectal or vaginal examination, or both, should always be made, particularly in those cases in which abdominal palpation gives negative results. In these, rectal examination demonstrates points of marked tenderness, sometimes fulness. Is of greatest value when appendix points south.

Tenderness increased—

1. Early pus formation.
2. Gangrenous change.
3. Perforation.

Tenderness decreased—

1. Discharge of fæcal concretion.
2. After free evacuation.
3. In late pus cases with enough septic absorption to paralyze nerve filaments.

Abrupt cessation of pain indicates gangrene.

Pain and Tenderness on left side: appendix points south (rarely east) and occupies pelvis. Vesical symptoms common.

Pain on left side with tenderness over pubis: appendix points south; tip of appendix affected and contains pus.

Pain on left side with bilateral rigidity: appendix points south with pus collection surrounding it.

Pain over hepatic or right renal region with tenderness over course of ascending colon: appendix lies post-cæcal or post-cæcal and post-colic, and points north.

Fulness appears late, after pus formation.

Excessive tenderness most reliable sign of pus.

Distention:—(*a*) Localized—is due to localized peritonitis.
(*b*) General:—

1. Constipation.
2. Opium.
3. Paralysis of intestines.
4. Mechanical obstruction.
5. General peritonitis.

Tumor is often impossible to detect on account of tenderness and rigidity. When adhesions and infiltrations are present detection usual. Rectal examination often successful when abdominal palpation is of no avail.

Chill is *rare* in denoting pus formation.

DIFFERENTIAL DIAGNOSIS.

TYPHOID FEVER.

There are several diseases which may be mistaken for appendicitis, chief among which are typhoid and the various affections of the genito-urinary tract. Some of the rarer cases in which a differential diagnosis is difficult will be touched upon below.

Typhoid fever and appendicitis are most frequently sources of diagnostic perplexity,—so much so, indeed, that upon more than one occasion I have seen the surgeon forced to defer operation in appendicitis, because the opinion of the majority of the medical attendants was opposed to such a procedure, they holding the case to be one of typhoid fever. Yet in the early stages of the two affections the characteristic symptoms are distinct. The sudden onset in one previously well, the rigidity of the right lower abdominal wall, and the tenderness limited to the position of the appendix, are collectively pathognomonic of appendicitis. In typhoid fever, the slow onset attended by lassitude, the headache, the epistaxis, the temperature record; the diffused abdominal tenderness with the relaxed condition of the abdominal walls, the enlarged spleen, and the absence of rigidity should be sufficient to establish a differential diagnosis with absolute certainty. If, in connection with these differential points, a digital examination of the rectum demonstrates a sensitive mass, then any doubt of appendiceal inflammation should be at once dispelled. Spots may be found, but they are not of absolute diagnostic value, since they may be present or absent in both affections and are in each due to sepsis.

Follicular abscesses of the appendix are responsible for some mistakes in the differential diagnosis between appendicitis and typhoid. The minuteness of the collections account for the mildness and the prolongation of the sepsis, and the lessened degree of the local symptoms. In this type of appendicitis we have a constant source of absorption with a small amount of tissue involved. The temperature record and the general condition in such cases in many respects closely simulate irregular typhoid, and much care in examination is essential, since it is not uncommon to find supposed typhoid fever cases in which operation has demonstrated the presence in the appendix of macroscopic follicular abscesses, varying in size from a millet to a mustard seed, an eroded mucous membrane, and a more or less infiltrated organ.

The points to be borne in mind in making a differential diagnosis between appendicitis and the later stages of typhoid are of sufficient distinctness, but each symptom must be conscientiously studied. The early history and the local symptoms on the one hand; the general abdominal and mental symptoms, with dry tongue, and the temperature record on the other, are quite sufficient to make differentiation clear and distinct. The spleen is enlarged in both affections. The enlargement, however, due to septic infection from an active suppurative process like appendicitis, is apt to be associated with pain caused by a peri-splenitis. Difficulty, however, exists, and the following case is related to illustrate the fact that follicular abscesses in the appendix are capable of causing a train of symptoms which suggest typhoid fever:—

Dr. M. consulted me about his little girl, because the nature of her illness was not clear to him. He related to me the history of the case and showed me the temperature record. I suggested that the symptoms resembled those of subacute appendicitis. An appointment was made with a physician, one of my assistants, and Dr. F. of the German Hospital. In consultation the following conditions were noted: there had been slight epistaxis

about seven days previous to date of examination; the temperature record was irregular, dropping suddenly on the fifth day from 103 degrees to normal. The tongue was dry and coated, with red borders, and while headache was present the mental condition was quite clear. The spleen was somewhat enlarged, and on the abdomen, which was slightly tympanitic, were noticed some indistinct rose-colored spots. Only very careful questioning of the mother elicited the fact that the child had been ailing for several months with digestive troubles, which, never severe, had always yielded to a purgative dose of castor oil. Examination of the right iliac fossa demonstrated distinct tenderness, also gurgling. No mass could be made out. One of the consulting physicians inclined to the diagnosis of typhoid and advised delay. The two other consultants diagnosed appendicitis, basing their conclusion on the previous history, the absence of mental symptoms, and the distinct tenderness in the right iliac fossa. On the following day I saw the case, with permission to operate if I concurred in the diagnosis of appendicitis. This I did, and operated at once. The following conditions were found: The appendix was situated behind the colon, to which it was adherent; the mucous lining of the tip of the appendix, which was club-shaped, contained several follicular abscesses, the largest of which was the size of a split pea. Recovery was uninterrupted and rapid. The symptoms which had suggested typhoid disappeared immediately after the removal of the appendix.

Before directing attention to the points of differentiation between appendicitis and the affections attended with pus formation which may be confounded with it, I desire to say that the occasion for having to make a differential diagnosis between appendicitis with pus formation and other forms of pus collection should never arise, as in all cases of appendicitis, the appendix should be removed before pus has formed.

PYO-SALPINX AND OVARIAN ABSCESS.

The presence in the recto-uterine *cul-de-sac* of an inflammatory mass *in intimate relation with the uterus,* which renders it partially or completely immovable, and which can be clearly outlined by vaginal, bimanual, or combined vaginal and rectal examination, together with the history of a vagino-uterine infection, and the presence of a septic fever, establish the diagnosis of pyo-salpinx, or ovarian abscess. The essential points in the differentiation between these two affections and

appendicitis are the absence of the history of the three cardinal symptoms of the latter affection.

Inflammation of the right ovary may be confounded with appendicitis, as it is attended with pain, tenderness in the right iliac fossa, nausea, and fever. It is, however, always accompanied by disturbances of the uterine functions and is demonstrable by vaginal or bimanual examination. The tenderness is never so intense as in appendicitis and is not accompanied by a perceptibly enlarged appendix.

SUPPURATING OVARIAN CYST.

An appendiceal abscess and a suppurating ovarian cyst on the right side present some symptoms in common which may give rise to difficulties in diagnosis. These symptoms are: painful tumor in the right iliac fossa, which may be made out by vaginal, bimanual, and external examinations; vague symptoms of septicæmia; hectic temperature, and history of previous gastric and urinary irritation. The differences, however, are marked and can be distinguished by careful consideration. In ovarian cyst the onset is gradual and a history of some infection can generally be elicited. The pain is constant and of a dull character; by pressure the significant "ovarian pain" may be produced, differing from the colicky appendiceal paroxysms. The rigidity of the abdominal wall is not so marked as in appendicitis, while the tumor itself is more elastic, having apparently thinner walls and a more regular outline.

FIBROID TUMOR.

Appendicitis may be confounded with a local inflammation of a portion of the broad ligament overlying an intraligmentary fibroid tumor. The main points in the differential diagnosis are the history of metrorrhagia; the presence of a growth, detected upon vaginal examination; the tenderness

and pain, which is elicited by bimanual palpation, and which is confined to the part of the wall overlying the mass.

EXTRA-UTERINE PREGNANCY.

The history in these cases is usually that of partial or complete cessation of the menstrual flow for one, two, or more periods, generally accompanied by other symptoms of pregnancy, with collapse supervening upon an attack of acute abdominal pain. The pain is long-continued and paroxysmal, but not colicky. An irregular, bloody, vaginal discharge, generally lighter in color than the normal menstrual flow, and containing shreds of tissue, portions of the decidua, is present. Vaginal examination will detect a tender and sensitive mass in the *cul-de-sac*, unless the pregnancy be an abdominal one. In the majority of these cases there is a history of sterility for five or six years previous to the abnormal conception.

PAINFUL MENSTRUATION.

A condition which may be misleading in the differentiation from appendicitis is the sudden onset of pain occurring in young unmarried women of a neurotic temperament at the ushering in of the menstrual period. The onset is sudden, the pain is paroxysmal and accompanied by nausea. There may be more or less rigidity of the lower abdominal walls, unilateral or bilateral. The presence and the degree of the rigidity of the abdominal walls depends upon the amount of congestion of the ovaries, whether one or both be involved. The pain, at first paroxysmal, is most severe during the first day of the menstrual flow. After this it may become continuous and, in some instances, lasts during the entire period. The tenderness, like the rigidity, corresponds to the amount of the ovarian congestion. If both ovaries are involved the tenderness will be bilateral.

The pain at the onset differs, however, from that of appendicitis, being non-inflammatory and localized from the beginning, while in appendicitis there is general abdominal pain, which later becomes localized in the right iliac fossa, while marked intestinal symptoms are present.

MENOPAUSE.

Some women during the climacteric occasionally complain of symptoms resembling appendicitis. They suffer from localized pain in the right side, gastric and intestinal disturbances, and irregular temperature. As absence of the menstrual flow often exists, some difficulty may be experienced in reaching a correct diagnosis, particularly in those cases associated with obesity. The exact condition, however, may be established by careful inquiry into the previous history and by local examination, which latter means demonstrates absence of rigidity of the abdominal walls and no palpable swelling about the appendix. The flushes, backaches, and mental symptoms incident to the menopause will clear up the diagnosis. In this connection, hysteria may be alluded to, particularly as appendicitis gives evidence of becoming a 'fashionable' disease. The mere mention, however, of the nervous affection, with its ubiquitous symptoms, will suffice.

FLOATING KIDNEY.

Floating kidney is differentiated from appendicitis by the absence of the three cardinal symptoms and of fever, by depression in the right flank, by the presence of a movable tumor, characteristic in shape, which, by properly directed pressure, can be restored to its normal position. This condition occurs most commonly in emaciated females of a neurotic temperament.

FLOATING KIDNEY, WITH A TWISTED PEDICLE.

From floating kidney with a twisted pedicle, appendicitis may be diagnosticated by pain which radiates in the line of the ureter, is not increased to any marked degree by pressure; by the absence of rigidity of the abdominal wall; by a history of a movable tumor prior to the attack; by a depression in the right loin corresponding to the site of the kidney; by the presence of blood in the urine, and possible symptoms of uræmia.

NEPHRITIC COLIC.

Ordinarily, it should not be difficult to differentiate between nephritic colic and appendicitis, but misleading conclusions may be reached, owing to the fact that in exceptional cases of appendicitis there exist together pain referred to the umbilicus, retraction of the testicle associated with vesical tenesmus, and painful and frequent micturition. Error, however, can only occur in the early stages of appendicitis, as the symptoms later on are entirely dissimilar.

Renal colic is usually ushered in by a distinct chill, followed by excruciating pain in the loin posteriorly, which is relieved by pressure. This pain radiates along the course of the ureter and is much diminished by the voiding of urine, which often amounts to large quantities. In appendicitis, the pain at the onset is more diffused, is increased by pressure, and is in no way affected by micturition. In renal colic there is no rigidity of the abdominal wall, no tender mass in the right iliac fossa can be palpated, and urine examination shows characteristic alterations, *e. g.*, uric acid or phosphatic deposits, blood, etc.

I recall the case of a physician, in which the diagnosis of renal colic had been made, and in which the ureter was supposed to have been ruptured by the passage of a calculus. The autopsy revealed a gangrenous and perforated appendix with diffuse suppurative peritonitis.

PYO-NEPHROSIS.

From abscess of the kidney appendicitis differs in that the pain in the former radiates to the groin and testicle with retraction of the latter organ. Tenderness is elicited on pressure over the kidney. There is irritability of the bladder and diminished excretion of urine, which contains pus and possibly blood. In the absence of urinary symptoms, abscess of the kidney, and particulary if it be a floating kidney, necessarily presents greater difficulty in differentiation. In the latter instance, however, the tumor will be movable. I have recently operated on a case of acute suppuration of the kidney in which the urine was normal, and the diagnosis was made on the anatomic situation of the swelling. Nausea, sometimes with vomiting, is a fairly constant symptom in the renal cases, though of not much diagnostic value.

PERI-NEPHRITIC ABSCESS.

When the appendix holds a retro-cæcal position or occupies a deep ilio-cæcal fossa, together with the formation of pus, it may be mistaken for a peri-nephritic abscess, but the absence of intestinal disturbance and of the cardinal symptoms of appendicitis will be sufficient to clear up the diagnosis.

GROWTHS OF THE KIDNEY.

Neoplasms of the kidney are detected by palpation of the loin space, absence of inflammatory symptoms, continuous dull pain, frequent micturition, hæmaturia, and pyuria. Cystoscopic examination of the bladder with catheterization of the ureters may be necessary.

URETERITIS.

Inflammation of the ureter occurs as a sequela to inflammation of the bladder, or in connection with tubercular and

calculous disease of the kidney. The differential points are: the history; the presence of tenderness at the bladder extremity of the ureter, as made out by vaginal or rectal examination; the presence of deep-seated tenderness along the line of the ureter; the absence of rigidity of the abdominal walls, and the presence in the urine of pus, blood, and ureteral epithelium.

RENAL IRRITATION OF APPENDICITIS.

Too much stress cannot be laid upon the importance of urinary examinations, not only in the supposed kidney affections before mentioned, but also in appendicitis.

It is true that in most cases of appendicitis examination of the urine reveals slight abnormalities, such as traces of albumin, cylindroids, hyaline casts, renal and ureteral epithelium, pus, and, rarely, blood corpuscles. In the affection in which the kidney and its adnexa are primarily involved the urine will show pathognomonic peculiarities. The renal irritation of appendicitis is probably due to disturbances of the sympathetic nervous system, but may be the result of actual contact of the appendix and some part of the urinary tract. To cite an extreme case, I have recently operated upon a patient whose urine contained pus and epithelium from the pelvis of the ureter. There was present a swelling in the right loin accompanied by tenderness, extending in the direction of the attachment of the appendix, and the history of the three cardinal symptoms was elicited. I opened up the right iliac fossa, finding the appendix, which was post-colic and contained pus, pointing north, adherent to and in communication with the pelvis of the ureter, through which the contents of the appendix were being emptied into the bladder, thus explaining the urinary symptoms. The recovery was uneventful.

INTESTINAL OBSTRUCTION.

In intestinal obstruction the onset is more abrupt than in appendicitis, and the pain, remissive in character and of severer type, may be referred to the seat of the obstruction, or more commonly to the umbilicus; there is absolute constipation and inability to pass flatus, while persistent and uncontrollable vomiting occurs early and soon becomes fæcal. The temperature is normal or subnormal, until the advent of peritonitis. With the onset of peritonitis, regurgitant vomiting begins. The vomiting becomes fæcal, a condition that rarely occurs except in the later stages of appendicitis. Intussusception is the most common form of obstruction in children, while obstruction from bands and volvulus is more common in adult life. Tumors from these forms of obstruction are generally to the left of the linea alba. When obstruction is the result of intussusception, blood and mucus will be discharged from the rectum, and upon examination through this canal a tumor may be felt. The development of peritonitis in acute intestinal obstruction is marked by great abdominal distention. Shock and collapse appear early in obstruction. Such is not the case in appendicitis, unless it be of the fulminating type, and even then collapse appears later.

PERFORATION OF SOME PART OF THE ALIMENTARY TRACT.

This can only occur as the result of a pre-existing localized inflammatory condition, and should not be confounded with the perforation of an inflamed appendix, as perforation the result of appendicitis takes place as a sequence to the three cardinal symptoms.

GASTRIC ULCER.

Rarely appendicitis and gastric ulcer may be confounded, especially when both have become chronic, since in both the

pain is similar in character and increased by pressure. The location of the painful area in either varies, and is, therefore, not an absolute guide for a differential diagnosis. Gastric disturbances are common to both. However, the mode of onset differs in the two affections, gastric ulcer being of slow development, while even in chronic appendicitis a history of an abrupt onset can generally be obtained. In gastric ulcer, the relief of nausea and pain by vomiting, the appearance of the vomited matter, which is frequently streaked with blood, and the occurrence of gastric hæmorrhage, are symptoms sufficiently striking to distinguish it from appendicitis. In this connection, it might be mentioned that diseases of the pancreas, such as abscess, cyst, or impaction of calculus, which may give rise to symptoms resembling appendicitis, may have to be diagnosed by the exclusion of the latter.

CANCER OF THE CÆCUM.

This should not be confounded with chronic appendicitis. In the former instance, there is absence of inflammatory symptoms; palpation reveals the presence of a nodular swelling of slow growth, attended by progressive loss of flesh; the disease occurs usually late in life; there is absence of marked rigidity of the overlying abdominal walls, and absence of decided tenderness. When the disease has advanced to the extent of offering an obstruction to the fæcal circulation, there will be attacks of diarrhœa, associated with mucus and blood in the stools, and paroxysms of acute abdominal pain, the result of peristaltic action of the bowel. The peristaltic wave can be excited by manipulation of the growth, and can often be seen through the thin abdominal walls.

TUBERCULAR APPENDICITIS.

H. W., aged fourteen, was admitted to the German Hospital February 15, 1896, with the following history: During the past ten months he had had six typical attacks of appendicitis, but each time operation had been refused. On the day before admission he had complained of pain in his right side, which had rapidly grown worse until the entire abdomen had become involved. When examined his temperature was $104\frac{2}{5}°$; pulse rate 116; his abdomen was enormously distended, tympanitic, and tender, particularly in the region of the appendix, although the tenderness here was less marked than the amount of distention seemed to warrant. Rigidity was present only as part of the general distention and was equally distributed. There was no record of tuberculosis in his family; an area of dulness was found in his left lung posteriorly, but no tubercle bacilli were detected in the sputum.

On the day after admission his temperature fell to 101°, rising again in the evening to 104°. From the symptoms a diagnosis was made of tubercular appendicitis, with subsequent involvement of the general peritoneum, and operation was suggested and agreed to.

Operation: Upon section of the peritoneum a small quantity of a dark, odorless fluid escaped. The cæcum and appendix were bound together in a dense mass of lymph and the whole covered with tubercular patches, which were also distributed throughout the peritoneum. The cavity was irrigated, glass drainage introduced, and the wound closed. Patient died two months afterward.

Tubercular appendix

The white spots represent miliary tubercles.

DYSENTERY AND COLITIS.

While dysentery may resemble some of those rarer and unfavorable cases of appendicitis, in which diarrhœa with bloody stools and tenesmus are added to the three cardinal symptoms, yet differentiation can be established by local examination. In dysentery, though, there is diffused abdominal pain, there is no localized tenderness, and no mass is palpable. With respect to colitis see page 159.

TUBERCULAR PERITONITIS.

The early stages of tubercular peritonitis, especially in cases in which the appendix is perhaps primarily affected by the specific bacilli, offer great difficulty in diagnosis. The cardinal symptoms of appendicitis may be present and the endeavor must be to diagnose the tubercular nature of the affection. Careful examination of the patient for infection elsewhere, *e. g.*, family history, sputum, chest, glandular involvement, bone and joint diseases, may lead to the recognition of the cause.

The hectic temperature and night sweats may be of value. However, the most significant symptom is the presence of ascites, which in tubercular peritonitis appears early and amounts to a considerable quantity, though its recognition is often obscured by the intestinal distention. The pain and tenderness usually tend to diminish with the increase of abdominal tumescence. The case of H. W. (Plate XVI) is a typical illustration of the disease, which probably originated in the appendix.

SPLENIC ABSCESS.

This rare affection may sometimes be confounded with those exceptional cases of appendicitis in which pain is referred to the left hypochondriac region. In both there are gastric disturbances, pain, tenderness on pressure, rigidity over the

affected area, and similar irregularities in temperature. The previous history of the two diseases is, however, unlike. Traumatism usually plays a prominent part in the causation of splenic abscess, this being rarely the case in appendicitis. Then, too, splenic abscess occurs in general septic infections and in those constitutional diseases in which enlargement of this organ takes place and is due to embolism in the parenchyma of the spleen. In neglected cases of appendicitis splenic abscess is a grave complication, and the symptoms referable to the spleen may then predominate.

HEPATIC AND PERI-HEPATIC ABSCESS.

Appendicitis can be confounded with abscess of the liver or about the liver only when, late in the disease, a circumscribed collection of pus is in close relation with the appendix which holds a post-cæcal position and points toward the liver. The previous history, the hectic temperature of hepatic or perihepatic abscess, and the absence of a history characteristic of an acute appendicitis will be sufficient to establish the diagnosis.

RUPTURE OF THE GALL-BLADDER

will occasion severe pain, rigidity of the right rectus muscle and of the flat muscles of the upper abdominal walls. The symptoms presented may be so similar to those of a perforated appendix that an operation alone will reveal the true state of affairs. A previous history may help in the diagnosis.

ABSCESS OF THE ABDOMINAL WALL.

Between abscess of the abdominal wall and appendiceal abscess there should be but little difficulty in arriving at a correct conclusion. If the collection be in the superficial fascia it will be circumscribed, but if between the abdominal muscles it is likely to be diffused. The purely local character

of the abdominal abscess, the swelling moving with the abdominal walls, the absence of intestinal symptoms, the presence of local and constitutional evidence of pus, coupled with the history of the case, should be enough to render a differential diagnosis possible.

INCIPIENT INGUINAL HERNIA.

What must not be confounded with the discomfort attendant upon a chronic appendicitis is that of incipient inguinal hernia. I have frequently met with cases of marked intestinal indigestion in the absence of a palpably diseased appendix, accompanied by more or less discomfort if not pain in the lower abdomen, described in some instances as being dragging in character. In these a careful examination of the inguinal canal showed weakness of the abdominal walls at the site of the internal ring, and the application of a light truss was soon followed by the disappearance of all symptoms.

ENLARGED MESENTERIC GLAND.

An enlarged mesenteric gland may be mistaken for the appendix when palpating the abdomen in cases of supposed appendicitis. Their presence, however, is not significant unless accompanied by the evidence of acute inflammation.

MESENTERIC HÆMATOCELE.

As a result of traumatism, rupture of the mesenteric blood-vessels sometimes occurs, followed by the formation of a mesenteric hæmatocele. Under ordinary circumstances absorption takes place. When the hæmatocele undergoes suppuration, symptoms closely resembling chronic appendicitis may be observed.

But by bearing in mind the character of the onset and the absence of the cardinal symptoms of appendicitis a diagnosis is readily made.

A CIRCUMSCRIBED COLLECTION OF PUS

in relation with the iliac artery and occurring in acute or chronic appendicitis may be confounded with aneurism of that vessel. Though the pus formation may have transmitted pulsation, this is not expansile nor accompanied by a bruit.

HIP-JOINT DISEASE.

The presence of the characteristic deformity; inability to execute the normal movements of the joint; pain referred to the knee; arching of the lumbar spine when the limb is brought into the fully extended position, and absence of intestinal symptoms, should determine the diagnosis.

PSOAS-ABSCESS.

The difficulty attending the diagnosis between chronic appendicitis, and incipient psoas-abscess, that is, before the pus has passed any distance down the psoas-sheath, I have had forcibly brought to my mind. The chief points in favor of a forming psoas-abscess are the appearance of the patient, usually suggestive of tuberculosis; the information to be obtained by an examination of the spine; a complete temperature record, and a tendency to flexure of the thigh of the affected side. While the flexure of the thigh may be and is present in some cases of chronic appendicitis, it is, nevertheless, a far more frequent accompaniment of psoas-abscess. Palpation will in the great bulk of cases of chronic appendicitis determine the presence of enlarged appendix, while deep pressure over the right iliac fossa will, in case of psoas-abscess, reveal tenderness of the psoas muscle, but fail to disclose the presence of either enlarged appendix or the characteristic rigidity of the flat muscles of the abdominal walls.

LUMBAR ABSCESS.

In this affection the history of spinal disease, the position of the swelling, the œdema of the overlying tissue, the slow onset, and the absence of acute tenderness, rigidity, and intestinal disturbances, will suffice to make the differential diagnosis.

PNEUMONIA AND PLEURISY.

The onset in these two diseases is sometimes very acute and the pain in the side so severe as to cause rigidity in the abdominal muscles. If the right side be affected, the diagnosis is sometimes quite difficult, especially in children, who are unable to exactly describe their pain. Careful physical examination will, however, clear up the diagnosis.

BILIARY COLIC (GALL-STONES).

The diagnosis between biliary colic and appendicitis is at times difficult.

The onset in both is somewhat similar, namely, acute pain coming on suddenly, accompanied by persistent vomiting, which is more severe and prolonged in the former than in the latter affection. History of cases will generally show differences sufficiently marked to distinguish the two diseases.

Less severe attacks of biliary colic will probably have occurred at intervals of several years, accompanied by jaundice, which later almost invariably becomes pronounced, and with characteristic color and itchiness of the skin may persist in a slight degree during the entire interval between the attacks.

Biliary colic is frequently ushered in by a chill. Fever is absent, particularly in early stages of the disease. The bowels are usually constipated, as in appendicitis; when moved, however, the stools have a dark green color and peculiar mouldy

odor. If gall-stones are found, as is frequently the case, diagnosis is established.

The location and degree of pain differs from that of appendicitis, being in biliary colic more continued and severe, and radiating usually from the lower right chest margin to the umbilicus.

While in later stages pain may become constant, and involve the whole epigastric region, or extend even lower, it will, nevertheless, usually at intervals of two or three days, become localized and more acute in the region of the gall-bladder.

In appendicitis the localization of pain is always toward, if not directly in, the right iliac fossa, while between severe paroxysms there is marked tenderness at this point, and characteristic rigidity of the overlying abdominal wall.

PROGNOSIS.

The prognosis to be given in any case of appendicitis will depend more upon the form of treatment instituted at the onset, than upon any other factor.

If the appendix is skilfully removed within twenty-four hours from the commencement of the attack, the prognosis is favorable, and recovery will ensue in nearly all of the cases. If, however, the opium treatment is resorted to, an unfavorable termination is more likely, because by this method there will be an apparent amelioration of symptoms and the attending physician will receive the false impression that the disease has either been held in check or completely cured. It is much more likely, however, that the disease is progressing rapidly, and the attention of the physician will be at length attracted to the true state of affairs by a tympanitic abdomen, a "leaky" skin, and a running pulse.

It is true that some cases will entirely recover by medical treatment (16 in 400, according to Ribbert), and a slightly greater number will apparently recover from an attack. But the course of the disease is so variable that one cannot say positively, or even with a slight amount of assurance, what case will recover, so long as the diseased appendix remains within the abdomen. The exception to this rule is found in those cases which respond immediately to laxative treatment. These often temporarily recover from an attack without operative interference.

Those cases which apparently recover, but still have tenderness over the site of the appendix, often lapse into chronic inflammation, and warrant an unfavorable prognosis as long as

operation is deferred, for the inflammatory process may light up at any moment with renewed vigor, and jeopardize the patient's life.

Rarely we find the inflammatory process so fulminating that a widespread purulent peritonitis develops in such a short time that the surgeon cannot be called early enough to prevent it. The prognosis in these cases is less favorable, but the patient's chances are enhanced by immediate operation.

In other cases there may be a thrombus of the appendicular artery, followed by sloughing of the entire organ, and the consequent emptying of the contents of the cæcum and appendix into the general peritoneal cavity. Here again the prognosis is unfavorable, but surgical interference offers the only hope. Fortunately the number of instances in which the above conditions are found is small, and, therefore, the general prognosis in cases in which operative treatment has been immediately established is favorable.

Why the prognosis is unfavorable in the cases not treated by operation is plainly seen by reference to the pages on the pathology of the disease. It is impossible to foretell what will be the outcome of any attack. Some authorities claim that 95 per cent. of all cases will recover without operation; I cannot agree with this statement. Too often have I seen cases which, apparently recovering, or seemingly entirely recovered, had in a moment lapsed into a most critical condition. As far as general health is concerned, I believe that an unfavorable prognosis must be given to all those cases of apparent recovery in which appendiceal inflammation has become chronic. I consider a chronically inflamed appendix a menace to life on account of the indisputable fact that an acute attack is liable to supervene at any time. The case reported on page 126 will illustrate this point.

Another condition to be considered in connection with the

prognosis of chronic appendicitis is the danger caused by adhesions which may exist between the appendix and the surrounding structures, or between the cæcum and the bowel, or between adjacent coils of the intestine. No one can tell when these may produce mechanical obstruction of the bowels. Every band or adhesion formed in the peritoneal cavity makes the prognosis more unfavorable, and the probable presence of these adhesions must be considered in giving a prognosis.

The prognosis to be given after or during an operation will depend largely upon the conditions found. If there is a general purulent peritonitis, with "leaky" skin and running pulse, the outlook is ominous. If the pus is confined to the right iliac fossa by a limiting wall of lymph, the prognosis is better, but, again, it will be modified by the treatment previously instituted.

The prognosis to be given in cases complicated by abscess of the liver, pyle-phlebitis, phlebitis of the veins of the leg, etc., must be modified by the extent and intensity of the complications.

TREATMENT.

In the treatment of appendicitis my observation has forced me to the conclusion that there is but one course to pursue in order to obtain the best possible results, viz., to remove the appendix as soon as the diagnosis has been made. The appendix should be removed so early in the attack that there will be no danger of septic absorption, purulent peritonitis, or perforation supervening, and in those cases of a fulminating character which have been almost instantaneous in their progress from the initial symptoms to the inauguration of a purulent peritonitis from perforation or gangrene early operation is positively demanded. Sometimes it is impossible to institute early operative treatment for one of several reasons: the patient may not live within reach of a competent surgeon; he may not be willing to have this treatment carried out until it has become evident that his only chance of recovery is by operation; or there may be some serious underlying condition, as advanced Bright's disease, diabetes, tuberculosis, etc., which would forbid active measures. Under such circumstances, expectant treatment is the only alternative. This embraces rest in bed, the judicious administration of laxatives, restricted diet, and the alleviation of pain.

At the onset of an attack presenting symptoms which are at all suspicious of appendicitis, the patient should be put to bed at once and kept there until the disease has been either cured by surgical interference, or subdued temporarily by medical treatment. The latter consists mainly in the administration of laxatives. In most cases castor-oil should be given. If the nausea and vomiting are persistent, or if the stomach will not

tolerate castor-oil, recourse should be had to saline cathartics or calomel. In some instances, with early and continuous nausea, with or without vomiting, it is advisable to administer calomel at once, and thus take advantage of its dual action, *i. e.*, of allaying the irritability of the stomach and of producing laxation. The best method of administering calomel under these circumstances is in the powdered form; compressed tablets or triturates are popular, but they are not as serviceable as the powder, and, particularly if not freshly made, are not only insoluble and inert, but also liable to cause mechanical irritation of the stomach and provoke further emesis. The addition of a little bicarbonate of soda will hasten the laxative effect of the calomel. At times small and repeated doses of calomel will fail to alleviate the irritation of the stomach, and in these cases I have found that a solid dose of from five to 20 grains, repeated in an hour, if necessary, will often have the desired effect. If the nausea still persists, a small fly-blister, applied immediately below the ensiform cartilage, often proves of decided service.

I believe that laxatives should be administered in the beginning of every attack of appendicitis. Diarrhœa does not act as a contra-indication, as they are generally as urgently called for under this condition as under the opposite one of constipation. I give a laxative with threefold purpose: 1. To relieve pain by clearing the intestinal tract of all irritating materials. 2. To diminish the virulence of the attack, as I believe the presence of foreign or irritating material in the intestinal tract, and especially in that portion of it adjacent to the cæcum and appendix, has a favorable influence upon the development of the invading micro-organisms. 3. To set up an active peristalsis in the intestine and the appendix, and so help the latter to empty itself.

As a general rule, I prefer castor-oil, because it unloads the

bowel of fæcal matter without causing an outflow of serum from the intestinal circulation. Salts, on the other hand, cause liquefaction of most of the bowel contents, but solid particles of fæcal matter are liable to remain. In the later stages, however, where peritonitis has developed and a depletion of the intestinal circulation is desirable, salts are preferable.

I am perfectly familiar with the unfavorable opinions of a number of other writers upon the advisability of the administration of laxatives in appendicitis, but my experience has taught me that it forms the only successful, and therefore justifiable, treatment when operation cannot be performed. I do not hesitate, therefore, to offer it to my readers as sound and rational therapeutics. I repeat that laxatives should be given early and in sufficient quantity to produce thorough evacuation of the bowel, for they accomplish the most good when given thus, and before adhesive inflammation has resulted in a matting of the neighboring coils of intestine, which is the method by which nature imprisons the inflamed appendix, and tends to prevent infection of the peritoneal cavity in the event of perforation. I am certain that in the presence of commencing adhesive inflammation of the appendix and its neighborhood, less danger attends the evacuation of the bowel than that caused by a full bowel. The benefit of unloading the bowel far outweighs the danger of breaking up any adhesions that may be forming. In the later stages of the disease, after the barrier which protects the general peritoneal cavity from the inflamed and septic appendix has been formed, I do not advise active purgation, as the peristaltic contractions will tend to break down nature's safeguard against the spread of the affection.

Of all the therapeutic agents that have been used in the treatment of appendicitis, opium is the one which has been

most often responsible for the mistakes made in diagnosis, for the unsuspected development of untoward symptoms, and for the call for the surgeon when too late. There is a percentage of deaths from appendicitis which, beyond doubt, is due to the indiscriminate and injudicious use of this drug.

Opium is dangerous in the treatment of this disease or of any intra-abdominal inflammation, because it hides all the symptoms of the affection; it blocks up the bowels; it causes distention of the intestinal tract, and very often adds to the nausea. The worst objection to the use of the drug is its power to mask all symptoms, and too much stress cannot be laid upon this point. It is essential that there should be nothing at any time in the course of an attack of appendicitis to prevent a clear conception of the progress of the disease. In many cases, indeed, the symptoms will be ameliorated after a free evacuation of the bowels. On the other hand, there are so many that go from bad to worse, that we must be always in a position to observe symptoms of advancing trouble, which is impossible if opium is given.

One of nature's most reliable signs of disease is pain, and in appendicitis this pain is generally in proportion to the degree of the inflammation. If then our patient be dosed with opium, it will be impossible to judge what is taking place within the abdomen; there is, even for a short time, freedom from pain, which gives the impression that the disease is progressing favorably. Possibly it may be, but more often we find that the very case that is so quiet and restful now will shortly be writhing in agony and presenting all the symptoms of perforation or purulent peritonitis. The surgeon is then called, but is unable to tell accurately whether the distention of the bowels is caused by peritonitis or by opium; the patient is drowsy and cannot respond intelligently to questions; the pain is alleviated for the time, and the presence or absence

of tenderness cannot be determined. Had laxatives been given, the attending physician would have known that every symptom appearing was due solely to the disease; that distention of the bowel must be due to peritonitis; he would probably have had a surgeon in counsel days before the trouble had reached such a stage. It is true that there is nothing that appeals to the sympathies of a doctor more than suffering, and it is natural that he should attempt to relieve it at once. But instead of giving opium, which will block up the bowels, cause the retention of all irritating material, and mask all symptoms, he should order a laxative, cause free evacuation, and thus remove much of the irritation that is causing pain.

The use of opium to the exclusion of laxatives is, in my opinion, therefore, unjustifiable, most dangerous, and should never be countenanced. In the majority of cases, after the complete evacuation of the bowels the pain subsides. In a few, however, the pain returns with renewed vigor. This constitutes one of the strongest indications for operation, as it denotes perforation of the appendix.

The use of such remedies as veratrum viride, aconite, fever mixtures, etc., have no place in the therapeutics of appendicitis. The only remedies locally applied that have any beneficial effect are ice-bags and turpentine stupes, though occasionally hot applications may prove more grateful. Dry cold should always be preferred, as it acts as a local anæsthetic, modifies the degree of inflammation if applied early, and thus hastens resolution. The application of tincture of iodine, leeches, and blisters is especially contra-indicated, not only because they do no good, but also because they add to the patient's discomfort. Blisters are particularly objectionable on account of their macerating effect upon the skin, thus making a septic field for operation. The latter is also true of leeches.

The indications for enemata are the same as for the administration of laxatives; they should be given, however, only as an aid to the laxative, and not to its exclusion. Forced enemata should never be given to overcome the constipation consequent upon a paralytic condition of the intestine; for obstruction due to paralysis usually indicates perforation of the appendix, and a forced enema, under such conditions, may be emptied into the peritoneal cavity, as happened in the following case:—

Mr. B., twenty-seven years old, was seized suddenly with cramp-like pain in the abdomen, accompanied by nausea and vomiting, for which he was given morphia, gr. ¼, by his physician. The pain, nausea, and vomiting immediately ceased. Twelve hours later pain reappeared but was located in the right iliac fossa, and tenderness upon deep palpation could be elicited. There was but a slight rise in temperature—100°–101°, pulse 96.

His condition remained unchanged apparently for ten days, when obstinate constipation associated with tympanites set in. Calomel, Rochelle salts, and castor-oil were successively administered without effect. A high enema was then given, very little returning from bowel. Obstruction of bowel diagnosed.

Upon examining the case I found excessive distention of the abdominal walls, which were extremely sensitive to the touch, a rapid pulse, temperature 102°. The excessive tympanites precluded palpation of the abdominal walls; examination per rectum nil. Diagnosis from history, appendicitis with septic peritonitis from perforation.

Operation by incision through right semilunar line. Upon opening the peritoneum a large quantity of pus, fæces, and fluid escaped. Cæcum lifted up, when it was found that the appendix had sloughed off, leaving a large ulcerated opening in the cæcum through which the high enema had been forced into the abdominal cavity, possibly at the same time tearing the appendix from its cæcal origin. Opening in cæcum closed, abdominal cavity washed out, glass drainage introduced, wound closed.

Result, death; patient never reacted from operation.

Asafœtida suppositories are useful in relieving pain and aiding peristalsis.

The diet in all cases of acute appendicitis should consist of liquid foods, such as broths, the main object being to give only what will leave little, if any, residue in the intestinal tract. Beaten eggs, pancreatized milk, or buttermilk may be given.

In cases of *chronic appendicitis*, the patient should eat sparingly and avoid all foods that will overload the bowels with residue. All coarse or hard foods, such as grits, coarse oatmeal, tough meats, fibrous vegetables, etc., should be forbidden. Fruits which do not contain seeds, and from which the skin has been removed, may be eaten without danger.

To recapitulate: In acute attacks, when operation is impossible, the following measures promise the best results: Absolute rest in bed; liquid diet, as peptonized milk, champagne, broths, etc.; castor-oil or salts or calomel in small, repeated doses. Ice-bag applied locally. Asafœtida suppositories. For persistent nausea, small fly blister just below ensiform cartilage.

Although there may be a few cases that for one or all of the reasons stated cannot or will not have the benefit of early operation, yet the vast majority will depend upon the physician for advice. In every one of these, unless constitutionally contra-indicated, I believe that the appendix should be removed as soon as the diagnosis has been established. I recognize the fact that a very small percentage of all cases will temporarily recover without the use of the knife, but no one can tell which case will terminate favorably or which will go on to perforation and gangrene, with the train of fatal complications that is liable to follow. The best result in all cases is obtained by removal of the appendix in the beginning of the attack. *Appendicitis is a surgical affection, and should be treated as such.*

The first question that arises, after the diagnosis has been established, is concerning the character of the attack and its probable outcome. It is here that we come against the stone wall of fact, reinforced by logical conclusions founded upon experience. We cannot foretell, with even the slightest amount of assurance, the issue of any attack of appendicitis. The main point to consider is, then, shall we risk the patient's

life, or shall we accept the only alternative and remove the organ in its incipient inflammation? In this affection early operation is a conservative and not a radical procedure. We are not governed by the same reasons that influence us to perform the radical operation for the cure of simple hernia or for the removal of the uterus for a fibroid. In appendicitis we have before us the probable consequences of suppuration, gangrene, and perforation. The proportion of cases that have but one attack, remaining perfectly well after its subsidence, is so infinitely small, compared to those that have repeated attacks with an interval of invalidism, that I do not believe the rare exception should interfere with the rule, viz., that where practicable all cases of appendicitis should be operated upon as soon as the diagnosis has been established. Of course, I do not include cases in collapse.

It is sometimes advised to delay operation until there is evidence of pus, and that if there is any doubt as to pus formation the operation should be deferred. I could cite many cases where the operation was delayed until there was unmistakable evidence of pus, some of them having been delayed so long that the patient was moribund when the surgeon was called. To defer operation a certain number of days or even hours is to expose the patient to risks not justifiable in the light of the present status of appendiceal surgery. The best results and the smallest mortality are obtained when the operation is performed at the earliest possible opportunity. The diagnosis can and should be made in a few minutes, and the operation should follow as soon as possible. Why should we wait for the formation of pus with its dangerous sequelæ, since such a condition greatly adds to the dangers of an operation, particularly when that greatest of all absorbing surfaces, the peritoneum, is involved? One has but to picture to himself the two operations, one for the removal of an appendix without pus

formation, the other the removal of an appendix bathed in pus, to arrive at the only reasonable conclusion. In the first case we have a clean abdominal incision; the appendix readily removed and the stump covered with a serous coat and then invaginated into the walls of the cæcum; the external wound is aseptically closed. In the second case we open up a collection of fetid pus which in its escape comes in contact with the incision and its contiguous parts; we remove the appendix under unfavorable circumstances with possibility of infecting the general peritoneal cavity; the wound cannot be closed, but, instead, must be drained or packed with gauze, thus risking a subsequent ventral hernia. With these pictures in mind, I cannot see how the claim is tenable that it is better to wait for pus before advising operation. That delay is dangerous in the great majority of cases is certain; that a few cases will recover from the disease (16 in 400, according to Ribbert) cannot be denied; that some cases will have a subsidence of acute symptoms must also be granted; but that any one can foretell the outcome I most emphatically deny. Those men who are the least decided upon the question of operation are those who have been limited in their experience. One must see the cases in all stages to realize the dangers of delay; one must observe the effects of the various methods of treatment to be convinced that there is but one sure road to recovery, viz., early operation.

An analysis of 50 consecutive cases, selected from my case book, of primary attacks of appendicitis in which operation was performed, will illustrate the importance of the position I have taken in reference to early operation in this class of cases.

The length of time elapsing between the onset of the disease, as reported by the attending physicians, and the date of operation varied greatly:—

5 were operated on within 24 hours.

18 were operated on within 48 hours.
12 were " " " 72 hours.
1 was " " " 4 days.
3 were " " " 5 days.
9 were " " " 6 days.
2 were " " " 7 to 9 days.

Of the 35 cases operated on within seventy-two hours, 28, or 80 per cent., recovered and seven died.

Of the remaining 15 cases operated on between the third and the ninth day, ten, or 66 per cent., recovered and five died.

With the exception of fæcal concretions, which were frequently met with, the only foreign body discovered was the accumulation of a number of strawberry seeds in one case.

In those cases in which, for some reason, the operation was not performed in the first stages of the disease, and where the patient apparently recovers from the attack—the appendiceal inflammation becoming chronic — I believe the appendix should always be removed between the attacks, when the disease is more or less quiescent. There is no doubt in my mind that, without exception, every appendix that has been the seat of an inflammatory process is a source of danger to the life of the patient, liable at any time to acute inflammation, and should, therefore, be removed. The mortality from the operation in chronic cases is exceedingly small. In cases of so-called recovery, most often we find the patient a chronic invalid, with constant dread of another attack, troubled with indigestion and obstinate constipation or diarrhœa. We must also consider the results of inflammation that are not apparent to the patient, such as bands of adhesions that are liable to cause mechanical obstruction or chronic inflammation, that may spring into activity at any moment; we must consider the effect of the previous attacks, with the resulting mass of exudate and adhesions, binding the appendix down so firmly that there will

be added difficulty and corresponding danger when the organ is removed. That grave trouble may arise in a chronically inflamed appendix at any time is well illustrated by the following case:—

Dr. ——, while witnessing one of my operations for the removal of the appendix, told me that he had been troubled with a chronic appendicitis for some time. I volunteered the advice that he should have the appendix removed, and he concluded to do so as soon as he could arrange his business satisfactorily. About six weeks after our conversation I was telegraphed for to come to his home at once, as he was suffering from an acute attack. On my arrival, I found him suffering from purulent peritonitis, the result of perforation. Operation disclosed the belly full of fetid pus; the peritoneum the seat of a most virulent form of inflammation; the appendix gangrenous and perforated, and a gangrenous patch in the cæcum. Death ensued in about eight hours.

This is but one of many instances I have seen, and it is hardly necessary to say that in most of such cases operation promises but little.

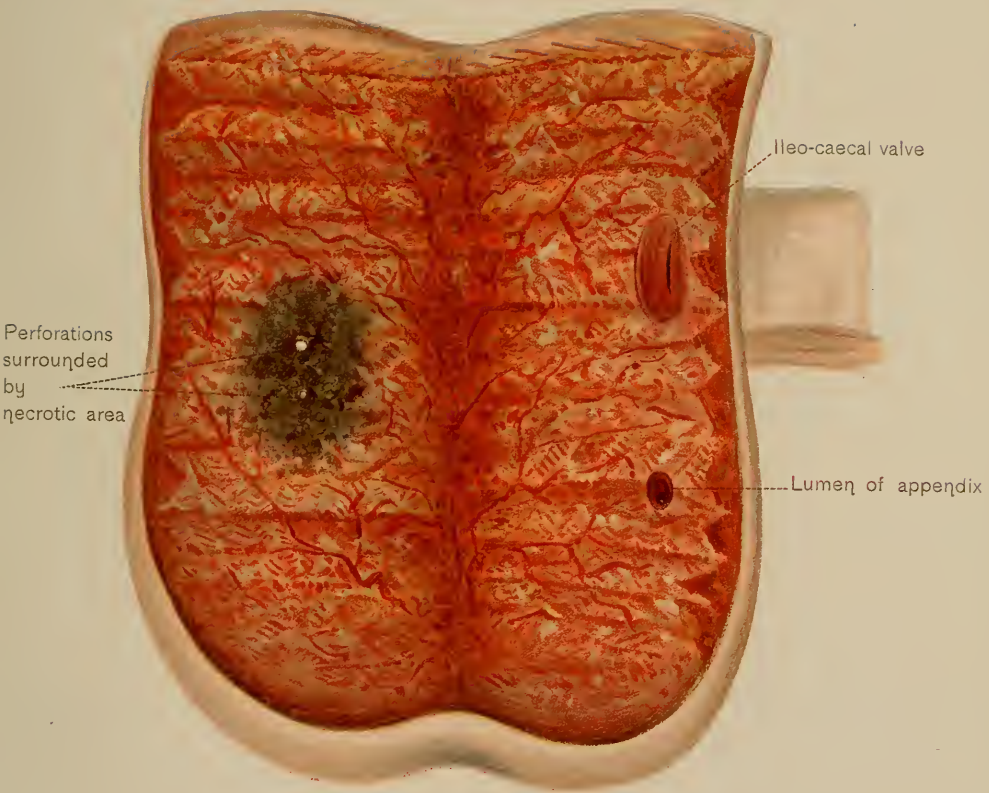
If pus has formed in an attack of appendicitis, I believe it should be removed at the earliest possible moment. The practice of deferring operation, in the presence of a purulent collection, for a few days, in the hope that the limiting membrane that forms the partition between the collection and the general peritoneal cavity will become stronger, is a procedure which I regard as unwise and attended by risks both immediate and remote. The immediate risks are from general septic infection, metastatic abscess, pyelo-phlebitis, and abscess of the liver. The remote risks are gangrenous perforation, spontaneous separation of the appendix from the cæcum, spontaneous separation of the appendix in its continuity, or necrosis and perforation of the cæcum from pressure of the collection against its walls.

H. W., age twenty-five, admitted to German Hospital January 15, 1896. Had his first attack ten days previous to admission, with sudden onset of pain in his right iliac fossa immediately after eating, followed by rigidity and marked tenderness. Remained in bed two days and symptoms abated, though there was still pain on right side, which increased by motion. No vomiting; constipation. At the time of admission he had the following symptoms: Tenderness on pressure over McBurney's point and marked rigidity on right side; by deep palpation mass could be made out; tongue coated; temperature normal.

Operation.—The appendix through nearly its whole length lay in front of the cæcum. The tip, however, was adherent to the posterior surface of the cæcum. [See Fig. 2, page 129.] It was covered by dense adhesions, upon the loosening of which about one pint of thick, fetid pus was discharged from behind the cæcum. The cavity was wiped out with dry gauze (no irrigation); the appendix was freed and tied off; gauze drainage was left in and the abdominal wound closed.

For sixteen hours after operation the patient did well and suffered little. Suddenly he had a sharp accession of pain over the epigastrium, was nauseated, and finally began vomiting greenish matter in which blood was discernible. Distention slight. Wound was dressed, gauze taken out, and cavity cleansed. Delirium set in, vomiting became continuous, and death ensued on third day after operation.

Post-Mortem.—Incision closed and in good condition. In the upper posterior aspect of the cæcum were two small perforating ulcers surrounded by necrotic areas. Cicatrix of appendix amputation scarcely discernible.


Ileo-caecal valve
Perforations surrounded by necrotic area
Lumen of appendix

In these cases the cæcum may be so involved from pressure that at any time it may rupture with consequent fæcal fistula, opening externally or into the peritoneal cavity.

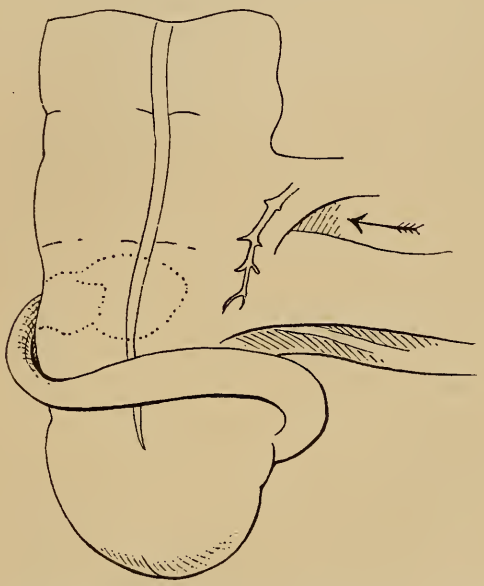


FIG. 2.—Showing Position of Appendix in Case of H. W. [Page 128.]

The case last reported as well as the following, both terminating fatally, perfectly illustrate this serious condition.

W. P., age thirty-six, was admitted to the German Hospital March 1, 1896, with the following history: For three weeks previous he had been complaining of gastric disturbance, headache, pain in his right side, and general malaise. Temperature was irregular, 99°–101°; tongue was coated; there was occasional vomiting and constipation. There were repeated attacks of pain, located in the right iliac fossa, at intervals of three or four days, dating from the beginning of his sickness.

At the time of admission his temperature was 101⅘°. He had slight sweats, and complained of pain in his right iliac fossa. Tenderness was marked, but nothing else could be determined by palpation on account of the rigidity and great thickness of the abdominal walls.

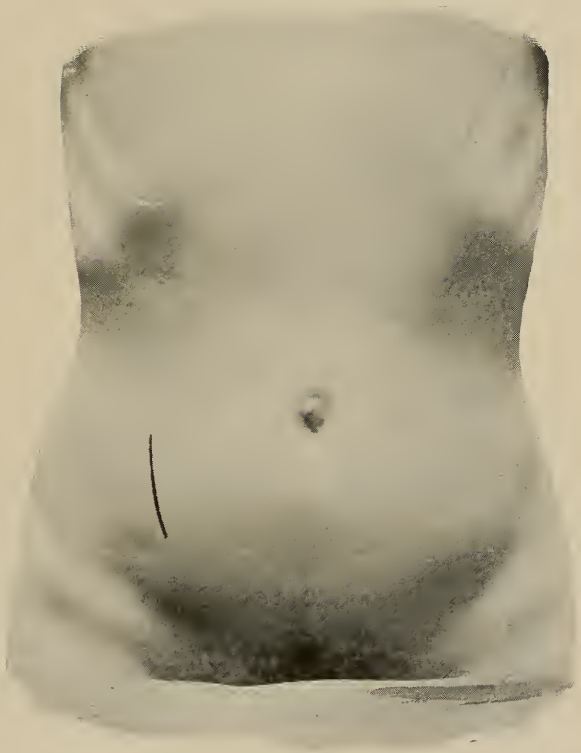
Operation.—A large abscess was found behind the cæcum. The appendix pointed N., and was so fragile that it was picked out in shreds from the lake of pus that contained it. The abscess-cavity was gently irrigated and a glass

drainage tube inserted to the site of the appendix, around which was packed iodoform gauze, and the abdominal incision closed.

For four days the patient did well, the temperature and pulse were normal, and the stomach retentive. On the fifth day he had sudden, sharp pain, abdominal distention, vomiting which became persistent, and died in a few hours.

Post-Mortem.—Purulent peritonitis ; cæcum perforated on the posterior wall. The opening corresponding to the site of the appendix was large enough to admit the end of the thumb.

Most of these conditions are liable to result in a fæcal fistula. I consider that the danger of leaving a diseased appendix in the abdominal cavity is greater than the damage likely to accrue from rupturing the partition wall in an attempt to remove it. I believe it is possible, and always advisable, to remove the organ and thus make the operation complete, as in no other way will recovery be assured, though I must emphasize the fact that this practice is only justifiable in skilled hands. For the occasional operator it is far safer that he content himself with a simple evacuation of the abscess. To leave within the abdomen an appendix which has sloughed off, or which has a perforation in it, or which has been intensely inflamed by migration of micro-organisms through its walls, I believe to be incomplete surgery. An appendix which is deeply imbedded in a wall of lymph, whether it form a portion of the abscess wall or not, can be removed. The proper disposition of gauze and careful attention to technique will, in experienced hands, render the dangers which attend the removal of the appendix much less than those which will threaten if it be allowed to remain. A practice which, I believe, is a frequent one, is to evacuate the abscess-cavity and, after affording drainage, to close the wound partially, without any effort to remove the appendix unless it happen to lie in plain sight. If the surgeon has a perfect knowledge of the anatomy of the right iliac fossa in the normal condition, and has seen enough cases to familiarize him with the con-



The Location of the Simple Incision

Fig. 1

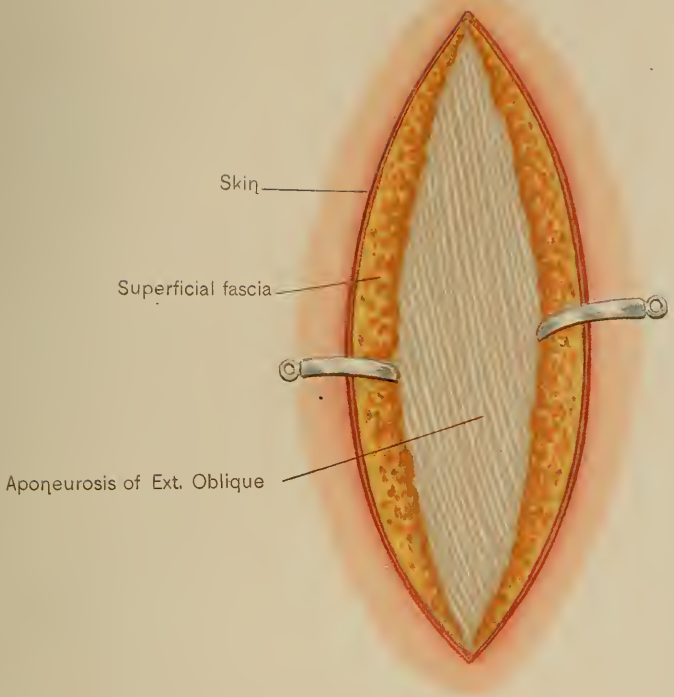
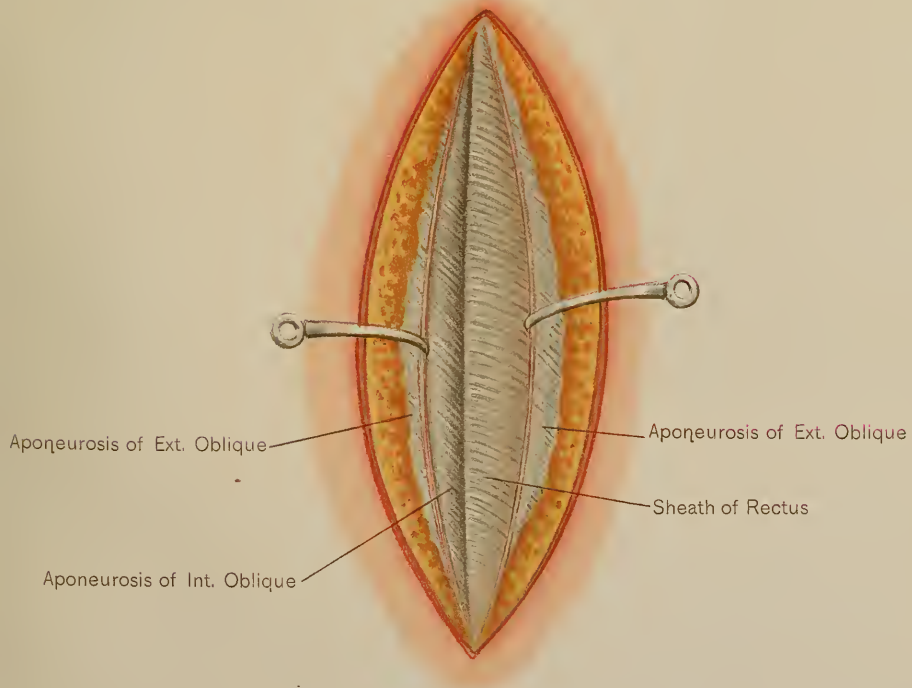

Skin
Superficial fascia
Aponeurosis of Ext. Oblique

Fig. 2


Aponeurosis of Ext. Oblique
Aponeurosis of Ext. Oblique
Sheath of Rectus
Aponeurosis of Int. Oblique

ditions generally found after disease, I fail to see why the organ cannot be found, as is claimed by some operators, though I grant that sometimes search is tedious and attended by difficulty.

Although I am a strong advocate of the removal of the appendix in almost every case of appendicitis, yet there are a few conditions in which I prefer to defer operation. Persistent vomiting, a leaky skin, a rapid pulse in the presence of a diffuse peritonitis, and approaching collapse, in my judgment forbid operation.

I have frequently been asked, when refusing to operate in such cases, why we should not give the patient his only chance. It is my belief that operation at this time is invariably attended by fatal results.

In these cases, ice to the abdomen, calomel given to the extent of moving the bowels freely, a small fly blister applied immediately beneath the ensiform cartilage, nutritious enemata, stimulants, as whiskey, dry champagne, hypodermics of strychnine, promise more than radical treatment. When by such means the general peritonitis subsides and the constitutional condition warrants it, operation may be done with the hope of a successful issue.

Though the technique of the operation for appendicitis varies with the nature of the case and the conditions present at the time of operation, there are, nevertheless, certain features, common to all, which should be carried out when feasible.

If the patient has chronic appendicitis, he should be confined to bed for from one to two days before the time set for operation. The diet should be light and easily digested, in order to leave a minimum of residue. The urine must be carefully examined, at least once, and oftener if time permits. This measure should never be neglected. The day preceding operation the bowels should be thoroughly evacuated by a

laxative and on the morning of the operation an enema given.

The patient is to be prepared for operation as follows: A general bath of hot water and soap, rinsing off with a saturated solution of boracic acid. An entire change of clothes, including bed linen. The immediate site of the operation is now to be scrubbed with thymol or green soap, hot water, and a soft brush, particular care being paid to the umbilicus. The immediate site and surrounding skin are to be shaved, so that hair, dead epidermis, and dirt may be removed. The abdomen should now be rescrubbed with soap and water. This is followed by the successive application of ether and alcohol upon a wad of aseptic cotton in order to remove any fatty material. Lastly, a thorough scrubbing with corrosive sublimate of the strength of 1 : 1000. A sterile towel or a large piece of gauze moistened with the sublimate solution is next to be placed upon the abdomen and retained by a bandage. The patient is then ready to be placed upon the table on the following day. After etherization and the arranging of sterile sheets and towels, the abdomen should be again washed in 1 : 2000 bichloride solution. We are now prepared to go on with the operation.

Of course, it is not always possible to carry out this detailed preparation in all cases, as it not infrequently happens that the operation has to be done at once or under unfavorable circumstances.

Incisions.—The two incisions most suitable for the operation of appendicitis are those which go through the abdominal walls to the right of the median line. They are the simple and the McBurney incisions. The median incision for appendicitis operations is not anatomical, is irrational and dangerous, particularly if pus complicates the case.

The simple incision divides the layers of the abdominal

Fig. 1

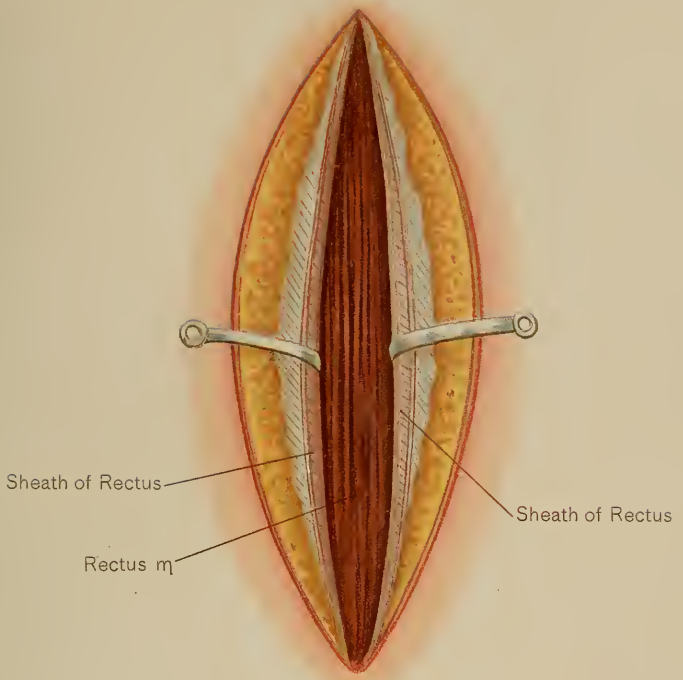
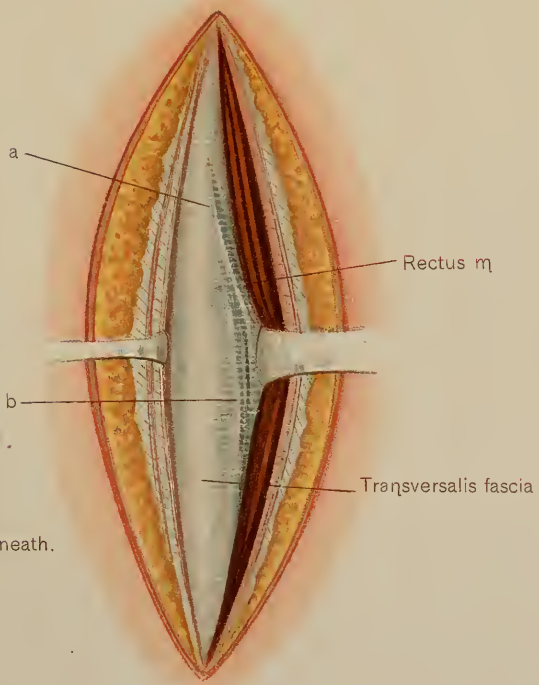


Fig. 2



a, b—Epigastric veins beneath.
Transversalis fascia

wall in the same longitudinal line, displacing the outer edge of the right rectus abdominalis inward, and is made a little to the inner side of the right semilunar line. The incision down to the peritoneum should be about three inches long, and begins one inch above a line drawn between the anterior superior iliac spine and the umbilicus; the incision intersects this line at a distance varying from one-half to one inch to the umbilical side of its centre. (See Plate XVIII.)

In pus cases where the collection is circumscribed it is often advisable to make the incision well to the right, running parallel and just above Poupart's ligament. This incision permits of better drainage and greatly decreases the danger of breaking through the inner wall of the abscess cavity in the manipulations necessary for the removal of the appendix.

The incision in the peritoneum should at first be one inch in length, simply large enough for the insertion of the index finger. Through this incision the cæcum can be picked up and brought out, and with it the appendix. If the cæcum or appendix be bound down, or if pus be present, it will be wise to enlarge the peritoneal incision. Bleeding should be controlled with hæmostats before the peritoneum is opened. The steps in this operation are illustrated in Plates XIX to XXIV inclusive.

McBurney has suggested a method of opening the abdomen, which, while more difficult of execution than the simple incision, is far less liable to be followed by ventral hernia. It is only applicable to those cases uncomplicated by pus.

The skin incision in this, the McBurney operation, is slightly curved, with the convexity outward. It is about two inches long and is midway between the right semi-lunar line and the anterior superior spine of the ilium. (See Plate XXV.) The section of the external oblique muscle and aponeurosis should correspond, great care being taken to

separate these tissues in the same line, and not to cut any fibres. This is easily accomplished.

When the edges of the wound in the external oblique are now strongly pulled apart by retractors, a considerable expanse of the internal oblique muscle is seen, the fibres of which cross the opening formed somewhat obliquely. Next divide the delicate fascia covering the internal oblique in the direction of its fibres. With a blunt instrument, such as the handle of a knife or the point of closed scissors, the fibres of the internal oblique and transversalis muscles can now be separated in a line parallel with their course, without cutting more than an occasional fibre. Blunt retractors should now be introduced into this incision in turn and the edges separated.

The transversalis fascia is now well exposed and divided in the same line, separating with it the preperitoneal fat. Last of all a transverse section of the peritoneum is made.

Two sets of retractors must at times be in use, one holding open the superficial wound from side to side, the other separating the edges of the deeper wound from above downward; ordinarily, however, I find one set of small retractors sufficient. A considerable opening is thus formed, through which, in suitable cases, the caput coli can be easily handled and the appendix removed.

The appendix having been amputated and the stump buried, the transverse wound in the peritoneum is then closed by continuous catgut suture. The parallel wound in the fascia transversalis is sutured in the same way. The fibres of the internal oblique and transversalis muscles fall together as soon as the retractors are withdrawn, but with a couple of fine catgut stitches the closure can be made more complete. The wound in the external oblique aponeurosis is closed with a continuous catgut suture. The skin and superficial fascia are now closely united by a continuous, sub-

Fig. 1

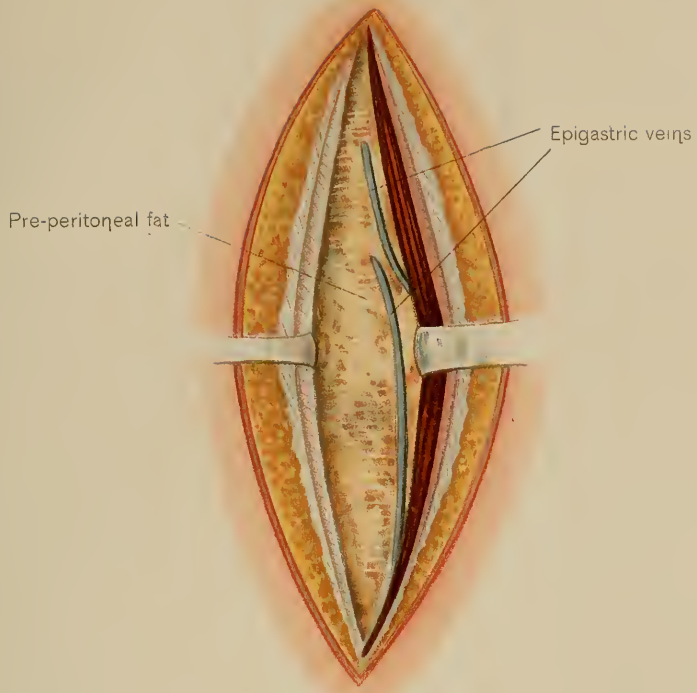
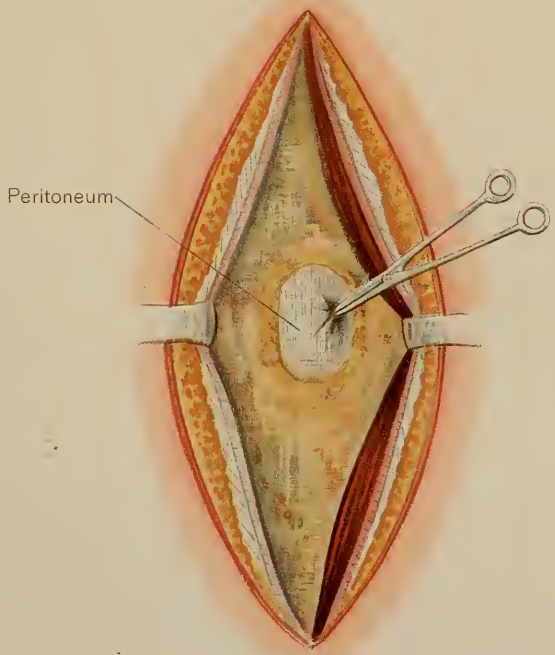


Fig. 2



cuticular suture and the wound hermetically sealed by iodoform collodion.

When the operation is completed it will be seen that the gridiron-like arrangement of the muscular and tendinous fibres, to which the abdominal wall largely owes its strength, is almost as completely restored as if no operation had been done.

Plates XXVI to XXXI inclusive show the various steps of the operation done by this method.

In performing this operation I have noticed several advantages.

In the first place, muscular and tendinous fibres are separated, but *not* divided, so that muscular action cannot tend to draw the edges of the wound apart, but, on the other hand, actively approximates them. Except during the incision of the skin, almost no bleeding occurs. The fascia transversalis, not being drawn away by the retraction of the deepest layer of muscular fibres, is easily sutured, and thus greater strength of repair is assured. No muscular fibres or large nerves having been divided, pain after operation is almost absent. The ilio-hypogastric is the only nerve encountered and should be pushed aside. The operation requires rather more time than the simple one. The opening into the peritoneal cavity is not large, but may be made larger, if necessary, by continuing the separation of the fibres of the internal oblique and transversalis, and dividing the conjoined aponeurosis in the same line with scissors. In the opposite direction the separation of muscular fibres may, upon necessity, be carried as far as the crest of the ilium, or the conjoined aponeurosis may be divided vertically.

In both operations it will sometimes be necessary to enlarge the incision after the peritoneum has been opened. When adhesions are strong and numerous, tying down the cæcum and appendix, it is wiser to have plenty of room in which to work.

This also is true when pus is present, and when, from the appearance of the right iliac fossa, secondary collections are suspected.

As soon as the peritoneum is opened, the cæcum should be delivered and with it the appendix. After the appendix is in the grasp of the thumb and finger the cæcum should be replaced in the abdominal cavity.

The meso-appendix is now to be tied off and cut away from its appendiceal attachment. This is accomplished by transfixing its base by a small pair of forceps. A piece of catgut is engaged in the jaws of the forceps, which are then withdrawn and with them one-half of the catgut ligature. After tying the ligature, the meso-appendix is cut away with a pair of scissors.

A circular incision is now made through the serous coat of the appendix one quarter of an inch from its junction with the cæcum. The serous coat is next stripped back toward the cæcum, leaving a cuff of peritoneum, after which the appendix is ligated with silk and the organ removed. The mucous membrane of the stump of the organ is curetted and antiseptic ized with a solution of mercury bichloride and carbolic acid (1 : 4000 and 1 : 60 respectively). The serous coat is stitched with a fine needle and silk over the stump thus left. The stump now covered with peritoneum is invaginated into the wall of the cæcum with continuous Lembert sutures. By this method of disposing of the stump, fæcal fistula is impossible, and therefore it is a method which should be carried out whenever circumstances permit. When the appendix is gangrenous or friable, or is much involved in inflammatory lymph, we often have to content ourselves with a simple ligature taking in all the coats of the organ. The stump thus remaining should, if possible, be invaginated into the cæcum.

Very often, in cases where pus complicates the operation, there

Fig. 1

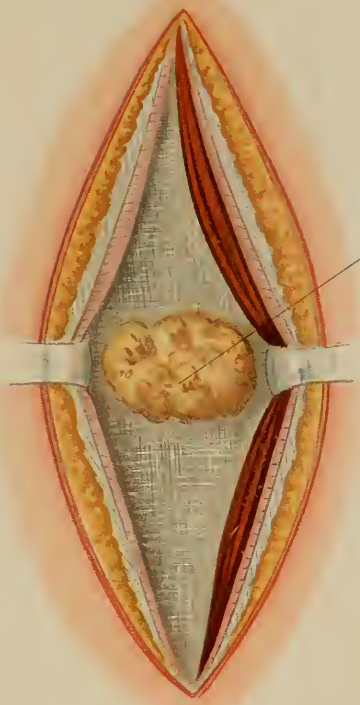


Fig. 2

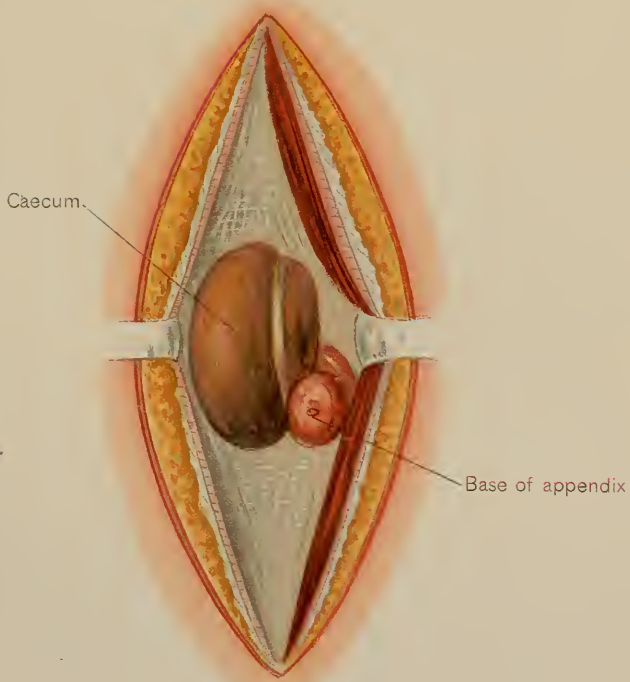
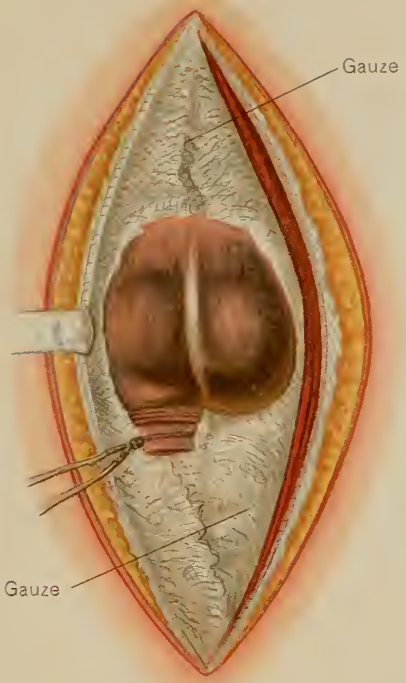
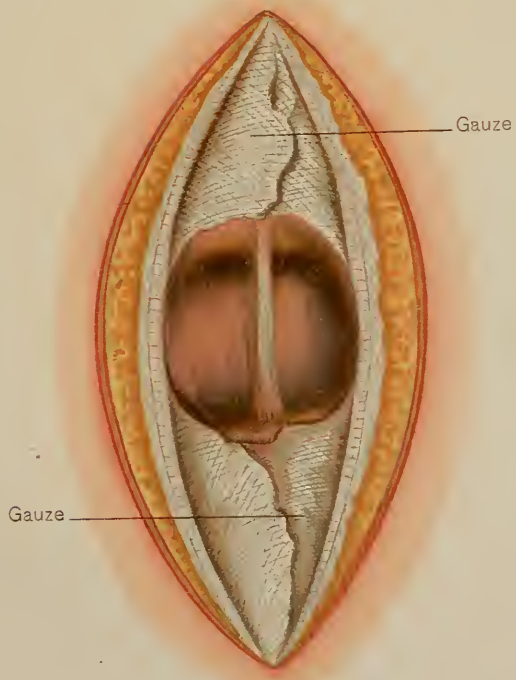


Fig. 1



Gauze distributed around bowel, serous coat turned back and appendix tied off

Fig. 2



Serous coat of appendix sutured over stump

is no confining wall of lymph, or if present it is incomplete or so delicate that the appendix cannot be removed without endangering the general peritoneal cavity. It is, therefore, a matter of the first importance that some method be instituted by which the spread of infection will be rendered impossible during the necessary manipulation for the removal of the organ. This is conveniently and thoroughly accomplished by the proper disposition of sterilized gauze. Pieces about six inches in length by four inches in width will be found most useful.

Since the success in the operative treatment of appendicitis complicated by pus formation will largely depend upon a knowledge of the anatomical varieties of this form of abscess, as well as upon a complete understanding of the safest method of evacuating the pus and removing the appendix without peritoneal infection, a brief description with the operative technique is here given.

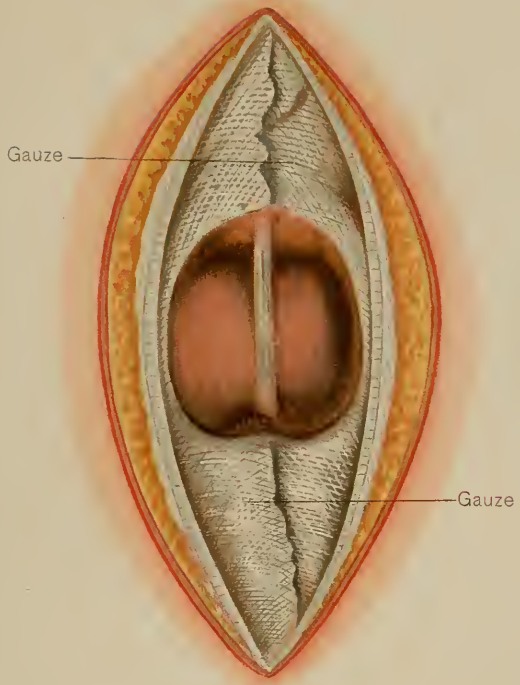
Depending upon the location of the pus, appendiceal abscess is met with as one of four varieties: First, and the most common in my experience, is the collection located post-cæcal, or between the layers of the ascending meso-colon; second, the collection is immediately beneath the anterior parietal peritoneum, being confined by the cæcum, coils of small intestine, the omentum, the appendix, the parietal peritoneum, and masses of lymph; third, the collection is located in the pelvis, which is usually entirely shut off from the general peritoneal cavity; fourth, pus is free in the general peritoneal cavity.

In dealing with the first variety, as soon as the peritoneal cavity is opened the first thing to be done is to protect the general peritoneum by the proper disposition of gauze, as has been described. The next step is to open the collection by breaking through either the outer layer of the ascending meso-colon or through the layer of lymph, attaching the outer wall of the

cæcum to the floor or the side of the iliac fossa, as the case may be. Turn the patient well over upon the right side and irrigate the cavity until the water returns clear. The cavity is now to be wiped out first with dry iodoform gauze, then with gauze wet with a solution of bichloride and carbolic acid. After drying the cavity with iodoform gauze the appendix is located and removed. After the removal of the appendix, and, when possible, the invagination of the stump, the cavity is to be lightly packed with narrow strips of iodoform gauze and the abdominal wall sutures introduced but left untied. The pieces of gauze used in walling off the general peritoneal cavity are now removed carefully and the wound aseptically dressed. After forty-eight or seventy-two hours the gauze packing is removed, first saturating it with sterilized salt or boracic acid solution; the sutures are tied and the wound dressed. It is not always possible to completely close the wound after the removal of the packing, but this must depend upon the condition of the wound. If there is escape of pus following the removal of the gauze, it will be necessary to allow the central portion of the wound to heal by granulation. It is in this variety of abscess, *i. e.*, with the collection post-cæcal, that the greatest difficulty is encountered in the removal of the appendix.

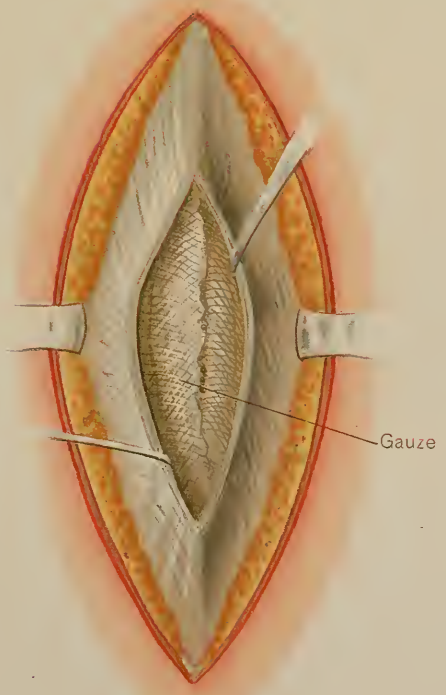
The evacuation of the collection located behind the cæcum and colon must of necessity entail opening the general or larger of the two peritoneal cavities unless an incision is made through the loin, as in opening a nephritic or peri-nephritic abscess. This method would suffice were the exact location of the collection known definitely beforehand and if the operator's intention was simply to evacuate the abscess and not to attempt to remove the appendix. The operator who believes it bad practice to take out the appendix in pus cases unless it appear right under his eye and finger, after having opened from in

Fig. 1



Stump of appendix invaginated

Fig. 2



Caecum replaced and gauze laid beneath peritoneal opening

front and determining that the collection is in this situation, can accommodate himself by closing the anterior incision and then proceed to do the loin operation. It is unnecessary to say, however, that this would subject the patient to an incomplete operation.

In the second variety, immediately upon carrying the incision through the parietal peritoneum, the collection is opened. The pus cavity is evacuated and antisepticized without irrigating. Irrigation in this variety is dangerous on account of the delicacy of the confining wall, rendering dissemination of infection more liable. Evacuation is ordinarily accomplished without risk of infecting the peritoneum since the incision which corresponds to the most prominent part of the swelling, or if no swelling is present, to the point over the involved region most sensitive to pressure, comes directly down upon the collection. This variety of abscess can usually be said to be present when the abdominal muscles along the line of the incision are found to be œdematous and infiltrated. If the muscles are not thus affected the abnormality will be found in the transversalis fascia and pre-peritoneal fat. Unless the case be of several days' standing, the amount of pus in this variety is small in comparison to the first class, and is therefore readily disposed of by mopping with pieces of iodoform gauze. After locating the appendix, it is dissected free and small pieces of gauze inserted as it is loosened from its bed, so that when the appendix is entirely free, its original site will be occupied by the pieces of gauze which were introduced during the dissection. It can now be tied off and removed, and the cavity and wound treated as in the first instance.

In this second variety of abscess it frequently happens that the collection is not completely shut off at its lower end, but is in communication with the pelvis; therefore, I make it a practice to pass a glass drainage tube down to the floor of the pelvis

to definitely determine its condition. I have on many occasions, when operating with this form of abscess present, evacuated but a drachm or two of pus upon cutting through the peritoneum. Upon passing a glass drainage tube into the pelvis as much as half a pint of pus has escaped.

In the third variety, the peritoneal cavity being opened it should be walled off down to the roof of the pelvis. The finger is then carried over the brim of the true pelvis down to the collection, and a glass drainage tube introduced with the finger as a guide. Irrigation is carried out through the glass tube. The appendix is now located and removed. After the removal of the organ the glass drainage is reinserted and left in place for from one to four days, depending upon circumstances. The gauze packing is to be removed and replaced by a small piece which is allowed to remain until adhesions have formed which will close off the cavity, usually in twenty-four or forty-eight hours. The upper portion of the wound is to be closed and only the lower portion, through which the glass tube and the end of the gauze packing protrudes, is allowed to remain open.

The evacuation of the collection through either the rectum or the vagina in the third variety of abscess, *i. e.*, pelvic, I regard as unsurgical and attended by more risk than incision through the abdominal walls. By the latter means it is definitely known what is being done, nothing being taken for granted.

In operating through the belly walls, the appendix can be removed at the time of evacuation of the abscess, a procedure which, in my judgment, is so important. Operation in these cases of pelvic collections has, in my hands, been among the most successful of all the cases of acute appendicitis attended by pus formation.

In the fourth variety, the general peritoneal cavity is to be

The Location of the McBurney Incision

Fig. 1

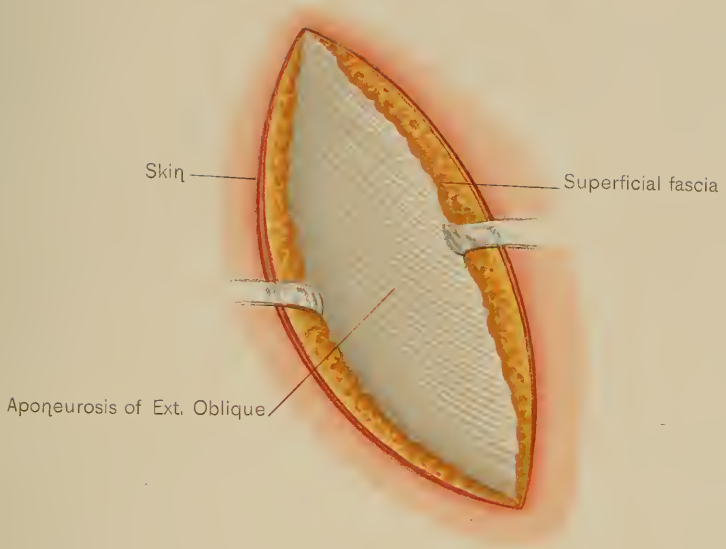
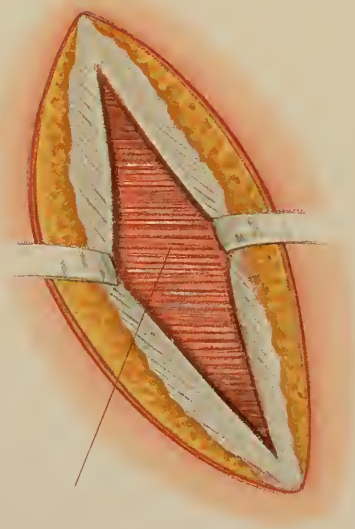


Fig. 2



Delicate fascia covering int. oblique m.

thoroughly irrigated, appendix removed, glass drainage introduced into the pelvis, and wound closed.

If the case is of long enough standing to have allowed extensive adhesions to form throughout the peritoneal cavity, it may be necessary to provide capillary drainage by means of strips of gauze distributed in various directions, because irrigation will not reach all the nooks and crannies of the peritoneal cavity when extensive adhesions have formed.

The fourth variety is met with in the very rapidly developing cases of appendicitis which call for immediate operative interference, and I have met with this condition within twelve hours after the onset of an acute attack, as the following case will illustrate:—

Annie B., colored, age forty-two, was suddenly seized on the morning of June 15, 1895, with acute abdominal pain accompanied by nausea and vomiting. She attempted to cook breakfast but was compelled to go to bed. Notwithstanding the use of home remedies and two large doses of castor-oil, which had moved her bowels very freely, she suffered excruciating pain.

Immediately after seeing her I advised operation, to which she gladly consented. I sent her to the German Hospital and operated the same evening. Found the abdominal cavity full of pus; a very much enlarged and acutely inflamed appendix which was covered with strips of inflammatory exudate. Removed appendix; washed out abdominal cavity with saline solution, and introduced glass drainage into pelvis.

Recovery speedy and uninterrupted. Returned to the house in three weeks, and resumed her duties as cook at the end of the fourth week.

There usually should be little or no difficulty in finding and removing the appendix in the fourth variety of abscess, as the anatomic landmarks are but slightly, if at all, impaired or distorted by the inflammatory process.

In the first three varieties it requires skilful manipulation to find and remove the appendix without infecting the general peritoneal cavity. In the first and third varieties, *i. e.*, the post-cæcal and pelvic collections, equally great care must be exercised to avoid infecting the peritoneum during the simple pus evacuation.

In cases where there has been no attempt upon the part of nature to wall off, or where there are no adhesions between the anterior layer of peritoneum, the omentum, and the underlying bowel, it will be necessary to place a series of pieces of gauze in different directions so that they will drain the general peritoneal cavity. This is accomplished by packing each piece in endwise and allowing the outer end to protrude from the wound. In closing the wound the stitches between which the ends of the gauze project are to be left long, so that they can be tied after the removal of the gauze.

Frequently after the completion of a toilet of an abscess cavity in the right iliac fossa, and particularly in that class of cases where immediately upon opening the peritoneum pus escapes, the general peritoneal cavity not having been completely shut off, a glass drainage tube carried down into the bottom of the pelvis will bring to light a hitherto unsuspected collection of pus.

In closing the abdominal wound one of several methods may be used: 1. Interrupted sutures including all the layers. 2. Buried sutures uniting the different layers separately.

However, the plan of procedure which I most often carry out in closing the abdominal wound in the simple incision, and which I believe to be the strongest safeguard against hernia, is that of buried sutures, the peritoneum and skin being stitched separately with continuous cat-gut suture and the muscles and fascia by mattress suture or simple uninterrupted suture of kangaroo tendon, silver wire, or worm-gut. The materials used in closing the incision are silk, silk-worm gut, kangaroo tendon, and silver wire. The last is most readily rendered aseptic and is the only one about the asepsis of which we can be absolutely positive. Where, on account of drainage, it is not possible to close the entire wound, place as many buried sutures as will close the wound to the point of exit

Fig. 1

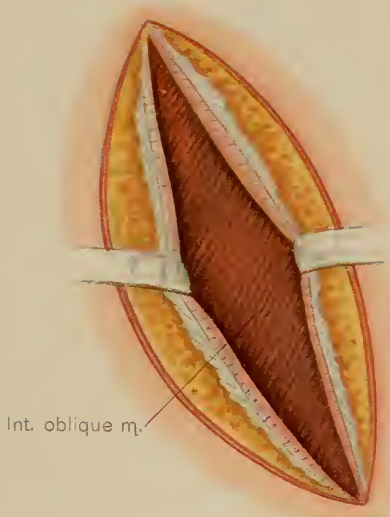
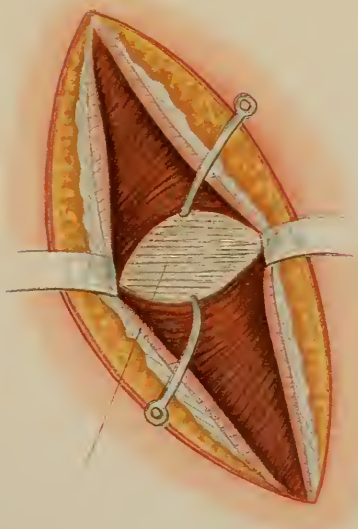


Fig. 2



Fibres of internal oblique and transversalis separated showing Transversalis fascia. a

Fig. 1

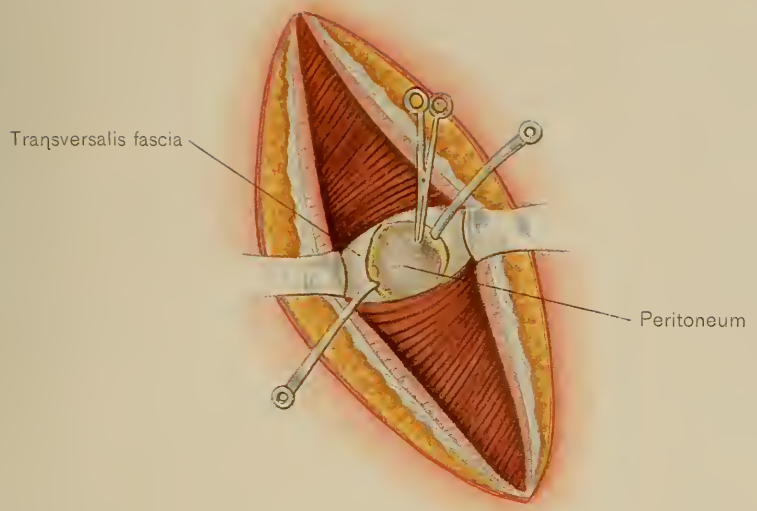
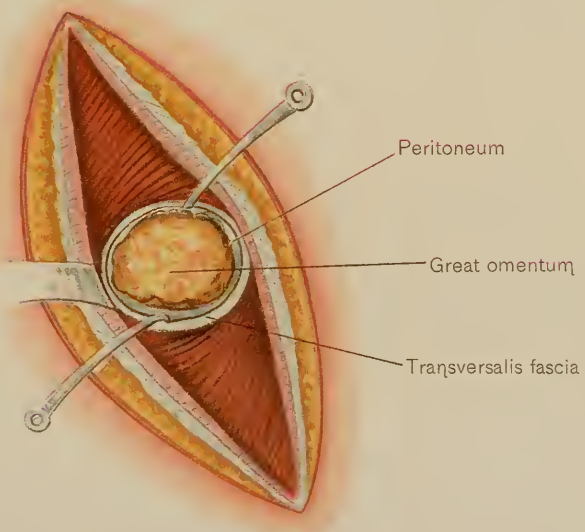

Transversalis fascia
Peritoneum

Fig. 2


Peritoneum
Great omentum
Transversalis fascia

of the drain, where two or more simple or buried sutures of silk-worm gut are placed. These two sutures are allowed to remain long and untied, so that the edges of the incision corresponding to the drain can be drawn together after the removal of the gauze or tube.

In closing by buried sutures, it will not be necessary in all cases to stitch the peritoneum, as sometimes its cut edges come evenly together when the edges of the wound are approximated. If, however, they do not approximate well, it will be necessary to stitch them together first with a continuous cat-gut suture.

The next layer consists of mattress sutures or simple interrupted sutures of kangaroo tendon, which, on account of its great strength, its durability against absorption, and comparatively easy aseptization, is an excellent suture material. The needle best adapted for this suture is a French instrument (Reveridan's) with the eye in the point, which can be opened and closed by a thumb service arrangement in the handle. A curved Hagedorn needle with a holder will answer the purpose, but is less convenient.

To introduce the mattress suture we begin on the outer side of the wound. The needle is thrust through the aponeurosis of the external oblique and through the internal oblique and transversalis muscles about one-half inch to the outer side of the incision. It next traverses the transversalis fascia, continuing out into the wound between the pre-peritoneal fat and the peritoneum, which last is not usually included in the stitch. After carrying the needle across the incision, it is thrust through the pre-peritoneal fat of the side opposite its point of introduction one-half inch from the inner edge of the incision. It now pierces the transversalis fascia, the rectus muscle, and its posterior and anterior sheath. A strand of kangaroo tendon is threaded into the eye of the needle, and by holding one end of the suture and withdrawing the needle, the needle end of the

tendon will be drawn through and the first part of the stitch will be in place. Disengaging the needle, we again thrust it through the tissues in the order above described, beginning one-half inch from the outer edge of the incision and one-quarter inch above the first point of introduction of the needle. When, following the course above described, the eye of the needle has penetrated the anterior layer of the sheath of the rectus, we thread one end of the suture which is already in place and withdraw the instrument, carrying with it the tendon. Now both of the ends are through the aponeurosis of the external oblique muscle to the same side of the incision, but one-quarter inch apart, thus giving us a U-shaped suture with two free ends. When these ends are tightly tied together we secure a firm suture, which brings together and retains those tissues, both muscular and fascial, which when united form a barrier to ventral herniæ. The only objection which can be raised against this method is the formation of a ridge along the line of opposition of the tissue included in the buried sutures. By using the simple interrupted buried suture this bunching of the tissue is overcome and the edges of the wound exactly proximated. I therefore prefer the latter method. In Fig. 3 the result with the mattress suture is shown; in Fig. 4 that with the simple suture. The skin wound is closed by a continuous, sub-cuticular suture as follows:—

Starting at the lower end of the incision, the needle is thrust horizontally in and out through the dermis of first one side, then the other, for distances of one-quarter inch until the skin edges are approximated throughout. The suture is fastened in the upper end of the wound. Silver wire is preferred by some surgeons for the continuous subcutaneous stitch, because it is not absorbable and therefore keeps the edges of the wound in apposition until perfectly healed, after which it can be withdrawn.

Fig. 1

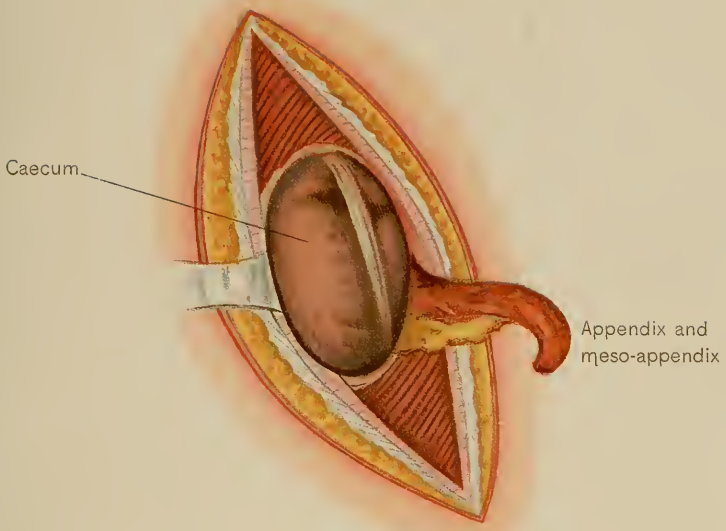
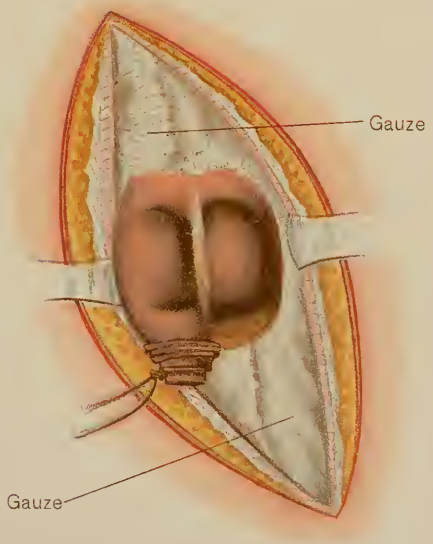


Fig. 2



The dressing for these cases consists of a layer of iodoform collodion and a strip of iodoform gauze, over which is painted a second layer of the iodoform collodion. The dressing is completed by placing a pad of sterilized gauze over the wound, retaining it in place by strips of adhesive plaster. The latter part of the dressing is to guard against sudden tension on the wound from muscular action due to coughing, straining, etc.

If in closing the wound when the simple incision has been used, the method of interrupted sutures including all the layers

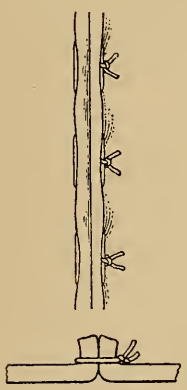


FIG. 3.

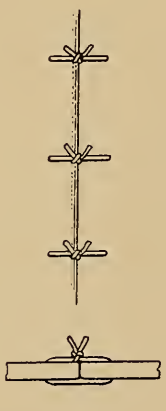


FIG. 4.

is followed, a long, straight needle, not too large in diameter, should be employed. The needle is thrust through the skin about one-fourth of an inch from the edge of the incision, pierces all the layers, running obliquely backward so that the opening it makes in the peritoneum will be about one inch from the edge of the incision. This insures contact of the edges of the cut peritoneum. The stitches are interrupted, being about one-fourth of an inch apart. Superficial stitches of silk can be used to overcome any gaping in the skin. Before the stitches for closing the wound are introduced, a piece of gauze should be spread over the underlying intestines so that they may be free

from danger of puncture. Bleeding which may occur will be absorbed by this gauze, which is to be removed before the stitches are tied.

A frequent accident in closing the simple incision is the puncture of one of the deep epigastric veins. I know of one case where such an occurrence caused the death of the patient from hæmorrhage. If this accident occurs, the surgeon is not justified in closing the wound until the vein is ligated.

The deep epigastric veins can be exposed by lifting up and drawing inward the rectus muscle, separating it from the transversalis fascia, beneath which they run. By remembering this fact, it is a simple matter to find and ligate the injured vein.

Some surgeons prefer the straight, round needle, as they think it less liable to puncture these vessels. I use the straight, spear-pointed needle, as it is much easier to manipulate and I believe does not increase the danger of puncture.

The armamentarium necessary for a complete appendiceal operation is as follows:—

Knife.

One pair of toothed forceps.

One pair of dissecting forceps.

Probe.

Six hæmostatic forceps.

One pair of simple retractors.

Catgut.

One straight needle, one long curved Hagedorn needle, or a handled needle with an eye in the point (Reveridan's), and twelve strands of silk-worm gut.

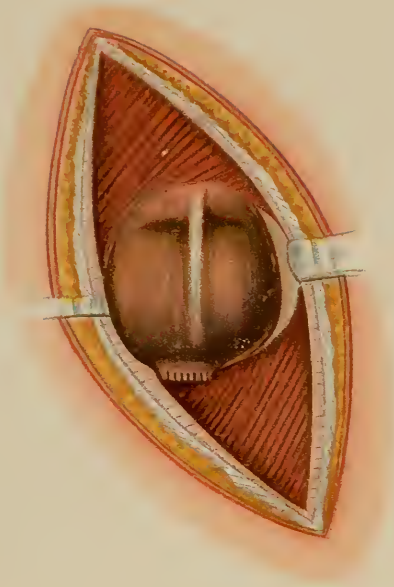
Kangaroo tendon.

Silver wire.

Small needle and fine silk.

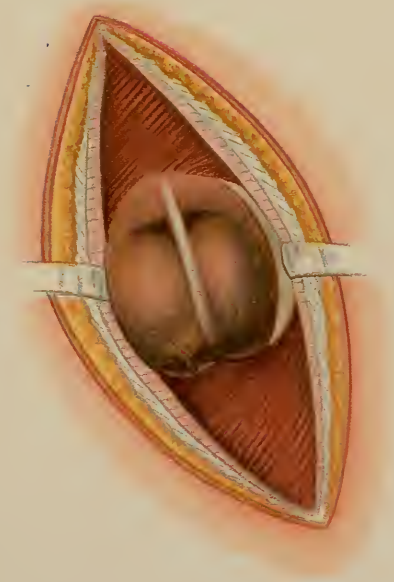
Ten yards of sterilized gauze.

Fig. 1



Serous coat sutured over stump

Fig. 2



Stump Invaginated

Fig. 1

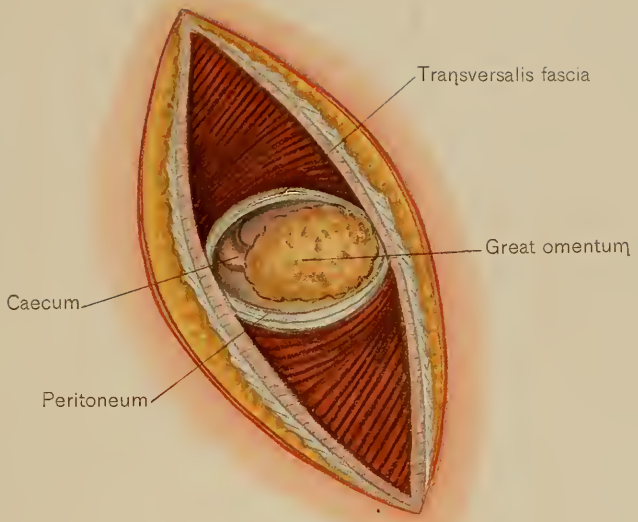
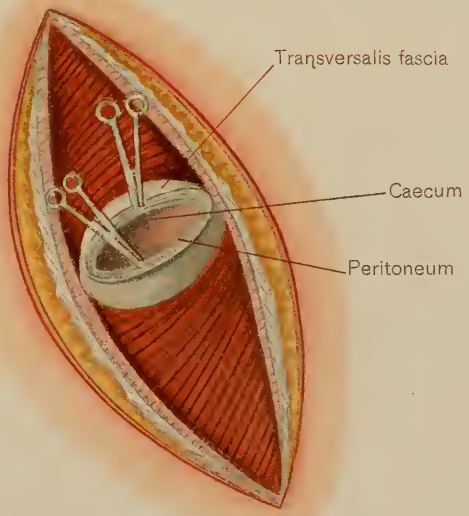

Transversalis fascia
Great omentum
Caecum
Peritoneum

Fig 2


Transversalis fascia
Caecum
Peritoneum

Two yards of sterilized iodoform gauze.

Sterilized cotton, adhesive strips, bandage, rubber dam.

Corrosive sublimate and carbolic acid.

Irrigating apparatus—salt solution; boric acid solution.

Drainage tubes, rubber, glass, various sizes.

Glass syringe.

The more the fingers displace instruments, the better the results.

COMPLICATIONS AND SEQUELÆ.

The complications of appendicitis may be divided into those which are encountered at the time of removal of the organ and those which arise during the course of the disease and interfere with the prompt recovery of the patient after operation.

Complications of the Operative Treatment of Appendicitis.—The condition of the abdominal walls may offer serious difficulty in removing the appendix. If, on account of a great deposition of fat, the belly walls are very thick, they will be harder to manage and increase the difficulty, both in finding the cæcum and appendix and bringing them into the wound; this difficulty can be overcome only by enlarging the incision. If the cæcum and appendix are tied down by adhesions, the difficulty in the operation will be correspondingly increased.

In a recent operation abdominal walls were encountered over two inches thick; the cæcum and appendix were firmly bound to the floor of the iliac fossa by exudate and adhesions. The appendix, which was very difficult to free on account of the thickness of the abdominal walls, was so friable that it was torn off in the endeavor to ligate it. The stump, moreover, could not be brought into the wound on account of the firm adhesions of the cæcum. A ligature, thrown around the stump, below a pair of hæmostats, was then tightly tied, and the stump invaginated into the walls of the cæcum and covered by stitching the coats of the cæcum over it by means of a short curved needle in a needle holder. These accidents and technical difficulties were largely due to the thickness of the

belly walls, which prevented free access to the seat of the trouble.

Much inconvenience and delay, moreover, is frequently caused by difficulties in effecting proper anæsthesia. Patients are often seen in whom it is almost impossible to produce complete muscular relaxation; in such cases there are rigid abdominal walls with the bowels bulging out of the wound at most inopportune times. A few drops of chloroform added to the ether will, however, generally overcome this trouble.

Unusual positions of the appendix will often cause the surgeon difficulty. I have frequently met with cases in which the organ might be supposed to be absent, being finally found lying against the posterior wall within the peritoneal covering of the cæcum, the one layer of serous membrane being reflected over both.

If, under these circumstances, a pus collection surrounds it, the appendix is sometimes exceedingly difficult to find, and its removal is correspondingly arduous. Under such conditions it is advisable to cut through the external layer of the meso-colon in order to gain free access to the appendix. This plan also diminishes the liability of infecting the general peritoneal cavity.

The appendix may be so rolled up in a fold of the great omentum that it is most difficult to decide which is appendix and which is omentum. In these cases it is proper to tie off and cut away the omentum along its attachment to the appendix, which last can then be stripped loose. This method ensures control of hæmorrhage from the omentum, and allows greater ease in dealing with the appendix.

The appendix is often encapsulated in a mass of exudate. If this cannot be stripped away, the thickest and firmest portion of it is cut through, whereupon the organ can be readily found, for that part of the exudate corresponds to the primary site of inflammation in the appendix.

Unless properly treated a meso-appendix loaded with fat will complicate the removal of the appendix, often by troublesome bleeding. A fat meso-appendix is always friable and liable to tear in handling, especially in tying off. It is best to remove it in sections, cutting away as the ligatures are tightened. This procedure minimizes the danger of tearing and the resulting hæmorrhage.

At times a necrotic or gangrenous condition of the apex of the cæcum is met with where it is impossible to find any tissue healthy enough to hold stitches introduced for the purpose of invagination. Under these conditions, I pack off the general peritoneal cavity and leave the gangrenous patch in situ. In a few days this separates, leaving a fæcal fistula which can be closed at a subsequent period if repair does not take place spontaneously. I consider this advisable rather than attempting to remove the gangrenous portion at the time of operation when one cannot be sure of the vitality of the tissue into which the sutures are introduced. If the gangrenous patch be invaginated and the abdominal wound immediately closed, fatal peritonitis due to perforation is imminent.

Conditions that may complicate the course of appendicitis and interfere with recovery.

Of these peritonitis is the most frequent. The prognosis depends upon the condition of the peritoneum at the time of operation. In all cases where the disease has advanced beyond simple infection of the mucous membrane of the appendix, inflammation of its serous coat is found; this, of course, can hardly be considered a complication.

Infection of the general peritoneum, however, may be the result of lymphangitis, of gangrene, or of perforation of the appendix or cæcum. A mild form is met with in which the peritoneum is injected, turbid, and sticky, but where there is neither effusion nor deposit of lymph. Prognosis good.

Again, the serous surfaces may be found glued together and a small quantity of a turbid effusion in the cavity. Prognosis good. If pus be present, one of two conditions will be encountered. In some, the peritoneum will be bathed in a quantity of odorless pus, the serous surfaces smooth and shiny, and the coils of intestine not glued together. Prognosis fairly good. In others, the pus will be less in quantity, but of a foul odor; the serous surfaces will be intensely injected and of a scalded appearance, and large masses of lymph, in different stages of organization, will be abundant. In these the streptococci or staphylococci are always present. When such conditions exist, the prognosis is unfavorable.

Obstruction of the bowel due to adhesions, the appendix itself acting as a band, is a frequent complication of appendicitis, especially in the chronic cases. The appendix is most apt to be at fault when holding some anomalous position. I saw a case where a band, the result of chronic appendiceal inflammation, was stretched between the appendix and a Meckel's diverticulum. Obstruction was caused by a coil of intestine becoming engaged beneath this band.

The appendix may be found adherent to any of the abdominal or pelvic viscera. It has even been found attached to the iliac blood-vessels. When the appendix is attached to any of the abdominal or pelvic viscera, great care must be taken in its removal, on account of the hæmorrhage liable to ensue. Fowler reports a case in which the gangrenous process caused by the inflammation of the appendix was communicated to the iliac vein. The vein is more often the seat of the gangrenous process than the artery.

Inflammation or thrombosis of the right iliac vein, associated with œdema of the corresponding lower extremity, is a complication sometimes seen due to a localized appendiceal abscess. If a fragment of the thrombus is carried into the general

circulation, septic pneumonia or general septicæmia may be the result.

If the appendix is very long and overhangs the brim of the pelvis, it may lead to disease of the pelvic contents, although such trouble may not be recognized until some time after apparent recovery from the attack or until after the removal of the appendix.

At times an appendiceal abscess will burrow upward behind the liver, either through or beneath the diaphragm, and finally rupture into the lung tissue. I have seen several cases where the abscess following appendicitis has been evacuated through the mouth. The following will be of interest in this connection :—

R. S., male, age nineteen, was admitted to the German Hospital, August 28, 1895, with the following history : Had always enjoyed good health until three days before admission, when after a heavy meal he began to suffer from pain in the epigastric region attended by vomiting, which afforded no relief. Pain increased in severity and became localized to the right iliac fossa, which was markedly tender upon pressure ; vomiting ceased but nausea persisted.

Patient thought himself suffering from mere colic and did not summon assistance until pain became unbearable. Was immediately sent to the German Hospital, where following condition was noted : Temperature 102° ; pulse 94 ; abdomen slightly distended and rigid, especially upon the right side ; pain diffused but tenderness marked in the right iliac fossa, the slightest touch causing the patient to flinch.

Diagnosis, appendiceal abscess.

By ice-bags locally applied and by free saline purgation the pain and tenderness abated, and operation was strongly advised, but absolutely refused by the parents. At this time the temperature ranged from 99–99$\frac{4}{5}$°, with a corresponding pulse rate of 84–100, the boy being fairly comfortable meanwhile, despite occasional nausea and vomiting ; the abdomen continued tender, though not to the same degree as previously. He remained in this condition until the fourth day after admission (making the seventh day from the initial symptoms), when he grew suddenly worse, the temperature rising to 104° and the pulse rate to 120. He vomited continuously, and was seized with dyspnœa, expectorating large quantities of fetid and purulent mucus tinged with blood. No tubercle bacilli found. Patient became exhausted and died nine days after admission. At the post-mortem, a perforated appendix, pointing north and lying just below the diaphragm, was found. The abscess surrounding the

appendix had penetrated into the lung, in which gangrenous patches were detected. The expectorated matter was evidently pus from the appendiceal abscess.

In some cases abscess of the liver is produced by fragments of thrombi being swept into the portal or general circulation. When the freedom of anastomoses among the veins of the mesentery is considered, it is not strange that this complication should occur, although it is not as common as might be supposed. There may be purulent infection of the pleura and pericardium as a sequence of the abscess of the liver. If the hepatic abscess attains considerable size, it may push through the diaphragm by ulceration and perforation. The symptoms attending this complication simulate those of pleurisy with effusion, or of pyo-pericarditis, or of gangrene of the lung.

ABSCESS OF LIVER—CASE NOT OPERATED UPON.

The following case came under my notice only post-mortem, and I submit it for several reasons: 1. To show the prevalence of pylo-phlebitis and liver abscess as sequelæ of appendicitis. 2. To demonstrate the importance of first excluding primary appendiceal inflammation in the diagnosis of all abdominal affections, particulary when pain and tenderness are not referred to the right iliac fossa. 3. To emphasize the value that should be attached to a previous history of attacks of colic, with gastric irritation, as indicating early involvement of the appendix, from which, as a source, remote organs may become infected.

A. R., white, age twenty-one, bartender. Family history, negative. Previous history, usual diseases of childhood. During the past eighteen months has had three or four attacks of colic, attended by vomiting. No mention was made of localized pain, and in a few days patient would apparently recover and go about his work as usual.

On March 1st patient developed sore throat, with stiffness in all the limbs, followed by excruciating griping pains in the epigastrium, which were

increased upon deep inspiration. Had headache and backache; also chill, fever, and sweats at irregular intervals; appetite fair; bowels somewhat loose. When seen on March 15th by his attending physician he presented the following symptoms: Temperature 103$\frac{2}{5}$°, pulse-rate 96; hectic flush on cheeks; had extreme pain and tenderness over epigastrium, and slight tympany; rest of abdomen, negative. Tongue was thickly coated, pupils normal; lungs and heart healthy; urine contained trace of albumen and a few granular casts; blood-count and hæmoglobin normal, though microscopically intra-cellular organisms resembling amœba of Laveran were noticed.

On March 16th, at 5 A. M., temperature 98°; pulse-rate 80. Had had a severe chill during the night, with profuse sweating; other symptoms same, except that a serous diarrhœa had set in.

Quinine exhibited without relief. There was no change in the symptoms until March 19th. Morning temperature 99$\frac{3}{5}$°; pulse-rate 104. However, a diffuse peritonitis had developed, there being extreme general abdominal tenderness, tympany, and rapid, irregular pulse. Diarrhœa continued and patient grew weaker. At 5 P. M., March 20th, temperature was 97°; pulse-rate 120. Death supervened early April 4th.

At the post-mortem, held eight hours after death, a general peritonitis directly due to a ruptured liver abscess was found. The appendix was perforated and imbedded in a mass of gangrenous adhesions. Purulent inflammation of the portal vein extended into the liver substance, and in the upper part of the right lobe were numerous embolic abscesses, one of which, situated upon the surface of the liver immediately beneath the diaphragm, had ruptured.

Appendicitis may complicate a hernia, and if the latter is strangulated or if a strangulation be suspected, the symptoms of the appendiceal inflammation may be entirely lost sight of, as the following case will show:—

Mrs. X., æt. forty-two, admitted to the German Hospital with the following history. Two days previous she had been attacked with general abdominal pain, associated with vomiting and absolute constipation. The attending physician found a mass in the right inguinal canal which the patient stated was an old hernia. The mass was tender and irreducible by taxis. Ether was administered also with no result. The patient steadily grew worse, and the next morning she was again etherized and another attempt was made to reduce the mass. This again was futile. She was then removed to the hospital, where I saw her. The mass was tender and inflamed, the abdomen was distended, the bowels were absolutely obstructed, and vomiting occurred frequently. Incision over the tumor showed that it was but the sac of an old hernia, and not the seat of the trouble at all. The peritoneal cavity was opened by extending the original wound, and a general purulent peritonitis was found. But the appendix was the seat of marked disease; it

was removed; the peritoneal cavity was thoroughly irrigated, drainage introduced, and the wound closed. The patient did not rally, and died in eighteen hours. The original site of the inflammation was undoubtedly in the appendix, but the mass in the right inguinal canal had misled both the attending physician and myself.

Abscess in the lumbar region may be found as a complication of a purulent appendicitis, and results from infection, by direct continuity, or by the vessels going to that region.

An abscess of the abdominal wall, consequent upon an appendicitis, may be found; this occurrence, however, is rare. The following case will be of interest in this connection:—

A boy of thirteen was referred to me by my friend, Dr. P. Moylan, with a history of three attacks of appendicitis. During the last attack he was under the care of Dr. Moylan, who said to me that at the time of his first visit a general peritonitis was present, and was attended with so much distention that he was unable to make out by examination the cause of the peritonitis. There was apparent recovery from this attack.

Operation was by incision through the right semilunar line, opening up a cheesy mass situated beneath the transversalis muscle. The peritoneum beneath the collection had been destroyed and the posterior wall was formed by the great omentum. The cheesy material was curetted away and the cavity antisepticized. The great omentum was tied off around the involved portion and the latter cut away. The cæcum contained two perforations, which were brought to view after the removal of the diseased and adherent omentum. The appendix lay post-cæcal, imbedded in a mass of lymph. It was perforated at its base. The pelvis contained a collection of pus which was confined by adherent coils of small bowel.

The patient recovered.

Pregnancy may complicate appendicitis. If the inflammatory condition occurs during the early stage of gestation, abortion generally follows. The usual risks of leaving a diseased appendix in the abdominal cavity are much increased by the pregnant state, and the evil consequences of another attack, *i. e.*, gangrene or perforation, will be correspondingly greater. The removal of the appendix is attended by few, if any, additional dangers to mother and fœtus.

It is a noticeable fact that quite a considerable number of patients who are neurasthenics suffer from appendicitis in the chronic form. Whether the dyspepsia, in the widest sense of that term, induced by the appendicitis leads to auto-infection and thus affects the nervous equilibrium of these patients must at present remain an open question. Some of such patients suffer in addition from colitis with mucous stools, which are even sometimes tinged with blood; in other cases the nervous symptoms are absent and only the colitis may be complained of.

Miss P., age forty-four, was referred to me with the following history: For the past three years she had suffered from a mucous diarrhœa which had been variously diagnosed entero-colitis, dysentery, etc., and treated, without benefit, by every method, from bismuth by mouth to quinine and nitrate of silver injections by rectum.

Upon admission to the German Hospital she was emaciated and markedly neurasthenic. Her bowel movements averaged four to eight daily, and contained mucus, shreds of mucous membrane, and blood. Upon careful examination the appendix was found enlarged and painful upon pressure; no rigidity.

She gladly consented to operation in the hope of relief, and the appendix, when removed, was found to be in a typical state of catarrhal inflammation.

Recovery uninterrupted. However, the bloody and mucous stools, the neurasthenia, and the emaciation did not markedly improve for over three months after operation, when her symptoms rapidly abated. She gained flesh, and within one year she presented herself as perfectly cured. The digestive functions were normal, the neurasthenia had disappeared, and she had increased in weight over twenty pounds.

The removal of the diseased organ, which latter is probably the primary cause of these troubles, leading as it does to inadequate digestion in the large intestine, colitis, etc., or simply to mal-assimilation, auto-intoxication, and neurasthenia, is primarily only of utility in removing the constant danger to life by which these patients are threatened.

The immediate effects of the operation on both the colitis and neurasthenia, however, are not so apparent. It often takes months or even a year and a half before decided improvement

F——, aged seventeen years, suffered from acute appendicitis with abscess. At the time of operation his condition was very low and it was thought advisable to evacuate the abscess only. Instead of the abdominal wall healing completely there were left two fistulous tracts, from which fæcal matter escaped (Fig. 2).

Ten weeks afterward the appendix was removed, when it was found that with the exception of the tip, the upper half alone remained, these parts being connected by a band of the meso-appendix (Fig. 1).

The opening in the appendix was in communication with the two fistulous tracts.

Recovery followed.

Fig. 1

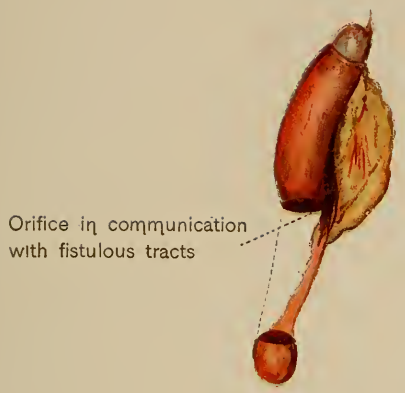


Fig. 2

Granulations surrounding fistulous tracts

is noticeable. But with appropriate treatment these patients in the end recover.

After operation for appendicitis a constipated condition of the bowels sometimes supervenes, which is occasionally quite obstinate and gives the patient considerable trouble. A systematic course of gentle purgation remedies this very unpleasant sequelæ. In this connection may be mentioned the apparently rational treatment by intestinal antisepsis. If a drug or a method of treatment were known by which the intestinal tract could be sterilized, no doubt the most gratifying results would be obtained. But, unfortunately, the various drugs, as naphthalin, creasote, etc., or high enemata, have proven quite inadequate, while some of the drugs employed are even dangerous.

These considerations emphasize the necessity for the physician to carefully examine even slight cases of colitis, mucous enteritis, neurasthenia, and allied disorders for possible appendicitis, since it is rational to expect that the sooner the cause of these various ailments is removed the sooner will the patient be cured of these disagreeable and annoying sequelæ.

Fæcal fistula is the most frequent and the most annoying of the *sequelæ* of appendicitis. In pus cases this is often due to the *appendix being allowed to remain after evacuating the abscess;* in others, it is due to a gangrenous area of the cæcum which was too large to close in at the time of the operation, or which developed after the removal of the appendix as a result of the original disease (see case of F——, Plate XXXII). A second operation may sometimes be necessary to abolish the fistula, but generally it heals without surgical interference. Fistulæ appearing early after the operation show much greater tendency to spontaneous closure than those supervening after some time has elapsed.

Hernia, following the operation, may occur in those cases where it had been necessary to introduce drainage. Some surgeons claim that they have never seen a hernia as a sequel of the operation, but this has not been my experience.

Where drainage has been introduced the wound closes by granulations, leaving cicatricial tissue which is decidedly weak and unable to stand the strain exerted upon it by the intra-abdominal pressure. I have never seen a hernia follow the McBurney operation, however, and seldom the ordinary operation, for if the wound can be closed immediately, the careful introduction of sutures will almost always prevent it. The relative frequency of hernia following pus cases with drainage is, of course, another argument for early operation.

While it may be a simple matter to operate upon a patient who has a hernia the result of an appendicectomy, it should, nevertheless, be borne in mind that any operation, however slight, is attended by danger; therefore, should a patient be subjected to the risk of a secondary operation, when one performed before pus formation will obviate this necessity?

A truss applied with the idea of curing or relieving these herniæ causes more damage than benefit, as the pressure thins the abdominal wall and makes a future operation less likely to be successful. If a hernia occurs after the operation for appendicitis, I believe it more satisfactory to immediately correct this defect.

When infiltration of the abdominal wall is found during operation, it generally signifies the presence of collections of pus. This infiltration is confined to the deeper structures mainly, the muscular tissue and transversalis fascia, from both of which serum exudes upon section. This exudation is pathognomonic of pus, and the peritoneum beneath is found infiltrated, thickened, and at times the pus is visible through it.

AFTER-TREATMENT.

Since the welfare of the patient after the operation for appendicitis depends upon close attention to details, the treatment outlined below may be considered as a safe guide.

The cases conveniently divide themselves into—

1. Simple, uncomplicated cases in which the wound is closed throughout at the time of operation.

2. Cases in which glass or rubber drainage is used.

3. Cases in which gauze is allowed to remain in the abdominal cavity, either for drainage or for protection of the general peritoneum.

For all cases, however, the following directions apply:— Patient should be isolated and under charge of a competent nurse. Temperature and pulse-rate should be taken every three hours for first two days.

After-effects of ether, as vomiting, tossing about in bed, should be guarded against. If great restlessness develops, knees should be tied together by a towel.

Patient should be kept warm by hot bottles.

Body should be protected against pressure of bed-clothes by a bed-cradle.

Rubber air-ring under gluteal region is a great comfort to the patient and relieves the pain in the back that is constantly complained of.

Urine should be drawn by catheter, if necessary, and carefully examined.

If stimulation is necessary, hypodermatic injections of strychnia ($\frac{1}{30}$), atropia ($\frac{1}{100}$), and whiskey (syringeful) may be employed.

No morphia.

Absolutely *nothing* by mouth for the first four hours. After that small pieces of ice may be given at fifteen minutes' intervals and the mouth and lips occasionally cooled by a moist cloth.

No nourishment should be given for at least the first eighteen hours after operation. If at the expiration of that time the stomach shows no evidence of irritability, tablespoon doses of peptonized milk with a teaspoonful of whiskey are cautiously given every two hours, which quantities are gradually increased according to individual circumstances. If vomiting supervenes during this period absolute abstinence for a time is again necessary.

For the relief of pain, which is always present, and which is due in most cases to intestinal distention, asafœtida suppositories (gr. v each) may be given as required; or if these fail, enemata containing two ounces of milk of asafœtida and three or four ounces of warm water may be injected, usually with marked benefit.

Calomel, gr. $\frac{1}{8}$, with bicarbonate of soda, gr. $\frac{1}{2}$, in powders, are begun twenty-four hours after operation at hourly intervals, and continued until eight are taken.

Persistent vomiting, which is liable to develop in any case, is treated by the application of a fly blister (two inches square) over the epigastrium; or by one-quarter grain doses of cocaine every two hours; or by teaspoonful doses of hot, strong, black coffee. Iced champagne may be of service.

We may now consider in greater detail the classification above mentioned:—

1. *Simple Cases.*—If the temperature and the general condition of the patient show no abnormality the wound requires no attention for the first five days. After that the dressing is removed, the stitches are taken out, and a simple aseptic dress-

ing is applied and allowed to remain for from three to five days. An abdominal supporter is then put on and the patient permitted to leave bed.

A sharp rise of temperature or much local pain with distention necessitate immediate renewal of the dressing, at which time a careful search should be instituted for the source of irritation.

Stitch abscesses should be opened and treated on general antiseptic principles. If pus has formed, the case merges into one of the varieties described below.

2. *Cases in which Glass or Rubber Drainage is Used.*—Since this method of drainage follows long and exhausting operations, careful attention to stimulation is necessary. If much blood has been lost and there are evidences of exsanguination, hypodermoclysis should be employed and from six to 20 ounces of a normal salt solution, at temperature of 100°, should be injected, preferably over the infra-clavicular or inguinal regions.

The glass drainage tube should be cleaned sufficiently often to avoid a large collection of fluid in the pelvis. When, after a three-hour interval, the fluid withdrawn is of an amber color and not more than one drachm in amount, the tube should be aseptically removed and the stitches, previously introduced and left untied, should now be drawn together and the wound closed.

The case thus becomes a simple one and should be so treated.

Rubber Drainage.—In these cases the cavity is carefully syringed daily with a warm five per cent. boric acid solution and the tube gradually withdrawn. After its removal the wound is closed and treated as above.

3. *Gauze Drainage.*—The dressing is left undisturbed until the second day after operation. At this time the pieces of gauze remaining within the cavity, having been carefully and thoroughly softened by copious applications of a warm five

per cent. boric acid or normal saline solution, are cautiously disengaged from adhesions and very slowly withdrawn. The cavity is then gently irrigated, packed with iodoform gauze, and dressed aseptically. The next dressing takes place after two days in the same manner. If the cavity is then clean the sutures inserted at the time of operation may be tied and the wound closed as above.

In the vast majority of cases involvement of the general peritoneum does not occur. Occasionally, however, as the result of perforation or lymphatic infection, or when it is present at the time of operation, this condition demands vigorous treatment. In such cases we are of the opinion that the local application of ice bags with calomel purgation and suspension of nourishment by mouth offer the best chance of recovery. While salines would be better adapted for draining the engorged peritoneal vessels, unfortunately the stomach will not often tolerate them.

When the constitutional condition indicates it, nutritious enemata of peptonized milk, bouillon, eggs, etc., may be of service.

In conclusion, it may be fitting to say that my attitude in the consideration of appendiceal surgery is the result, not of theoretical deductions, but of that best of teachers—experience. Therefore, after a close observation of over 500 of my own operative cases I give the foregoing views as my earnest convictions.

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